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M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

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MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

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THE Editor of THE RAILROAD AND ENGINEERING JOURNAL is now engaged in collecting material which he contemplates using hereafter in writing a history of American railroads. If any reader of the JOURNAL has in his possession, or knows of the existence of, any drawings or documents available for this purpose—such as drawings of old locomotives or cars, maps, profiles, etc., reports, or any other documents, written or printed—he will confer a favor by informing us of the fact. Any books, documents, or drawings which may be intrusted to the Editor for this purpose will be treated with the utmost care while in his possession, and will be returned safely to the owners.

THE month just closed has been a month of conventions, several of the most important railroad and technical associations having their annual meetings. The Master Car-Builders' and the Master Mechanics' Associations both met at the Thousand Islands, and the Car Accountants' Association at Montreal, while the American Society of Civil Engineers is holding its Annual Convention at Milwaukee as the month closes, and several less important societies are also on the wing.

Some men are disposed to disparage the importance of these annual gatherings, and to insinuate that more time is given to pleasure than to business. It is true that the actual results sometimes seem small, but it is also true that the opportunity given to busy men to leave for a short time their daily routine of work is worth a great deal. The friction of minds, and the interchange of new ideas is, after all, the best result of the conventions, and does much good to the members which is not expressed in the reported proceedings.

IT would naturally be supposed that the Traffic Associations, under whose charge so large a part of the passenger business is conducted, would be willing to favor a meeting of railroad men by giving every possible facility to those who desire to attend it. This should be especially the case with the meetings of the Master Car-Builders' and the Master Mechanics' Associations, whose deliberations are of so much service to the railroad companies. This year, however, it would seem as if every possible obstacle had been put in the way of those associations, at any rate so far as the granting of special rates and privileges was concerned. Excursion rates were granted and then withdrawn, and the grants renewed at the last moment, in such a way that all the arrangements were thrown into utter confusion, and the Secretaries of the two associations were unable to say what could, or what could not, be done. Independently of any consideration of the special claims of the Master Car-Builders and the Master Mechanics, it must be said that the manner in which this business was conducted is not calculated to give outsiders a favorable opinion of the management of the passenger business under their charge. The associations charged with such extensive and important interests should certainly be so organized as to be able to act promptly and with understanding upon matters coming before them, and, at any rate, should be able to give a definite decision without making continual and confusing changes. If it were not possible, or not advisable, to grant the railroad men special rates, a prompt and courteous refusal would have been very much better than the actual course which was taken.

Exception should, perhaps, be made in the case of the Southern Railroad & Steamship Association, which granted all that it could, freely and without delay.

THE committee which was appointed at the preliminary meeting of railroad accounting officers in Washington, has prepared a plan for the organization of an association and has called a meeting to complete such an organization, to be held in New York in July. The only wonder is that such an association was not formed long ago. In addition to the advantages to be obtained by comparison and discussion of methods, there are many other points which will at once suggest themselves, such as the arrangement of better methods for the prompt settlement of claims; the establishment of a uniform system of accounts for joint traffic; the adjustment of joint accounts, and the attainment of uniformity in accounts and returns. So large a proportion of railroad traffic now is through or joint traffic passing over several different roads, that some uniform system was long ago almost a necessity, and that its establishment through an association has been delayed so long is something not easy to account for.

Whether a general clearing-house system like that in use in England is practicable in this country is a question; the new association may lead in time to the establishment of such a system, as its discussions make it clear that nothing less will accomplish the desired objects.

THE steamer *Etruria*, of the Cunard Line, has succeeded in making the fastest passage on record across the Atlantic, having made the run from Queenstown to Sandy Hook in 6 days, 1 hour and 55 minutes, which is 2 hours and 47 minutes less than the time made by the *Umbria* of the same line not long ago.

The average speed of the ship on this voyage was 470 knots a day and 19.6 knots an hour, the actual distance steamed being 2,854 knots. The best day's run was 503

knots, an average of 20.9 knots an hour, an extraordinary rate of speed.

THE survey of the Nicaragua Interoceanic Canal is now practically completed. The line which will probably be adopted is substantially the same as that indicated by the preliminary reconnoissance made in 1885, the changes being slight. The actual amount of excavation required will be somewhat less than had been supposed, and in every respect the result of the survey was very satisfactory.

AN attempt is to be made to open a regular line to run between Chicago and Liverpool without transshipment. The steamer *Rosedale*, which recently arrived at Montreal from London, is to proceed directly to Chicago by way of the St. Lawrence River and the Lakes. The ship is a steel vessel 180 ft. long, 56 ft. beam, and 21 ft. depth of hold, and is small enough to pass the Welland and the St. Lawrence canals. She brings a load of cement from Liverpool, which is to be delivered in Chicago, and will return with a load of grain. This vessel, it is claimed, will be the first steamer which has ever gone from Liverpool to Chicago direct.

Several sailing vessels have made the voyage from Chicago to Liverpool and return, and at one time, some twenty years ago, there was considerable talk of the establishment of a direct line of this kind. It was found, however, that the vessels best adapted for the lake service did not possess the qualities required for a transatlantic voyage, and that the necessary transfer of cargo was in the end a much more economical arrangement than it would have been to build ships capable of making the entire trip, so that the experiment never resulted in anything further.

SEVERAL of the railroads running to New York are making considerable improvements in their terminal facilities. The Erie completed a new station in Jersey City last fall; the Delaware, Lackawanna & Western is building one at Hoboken, and the Pennsylvania contemplates the construction of a new station as soon as certain questions about the road through Jersey City are decided on. When all these improvements are made, however, it will remain a fact that New York has no terminal station which is worthy so large and important a city. At the best the stations on the Jersey City side of the Hudson are makeshifts, inferior to many which may be found in cities of less importance, while the Grand Central, the only terminal station really within the city limits, although somewhat improved by the recent addition, is a monument of bad design and awkward arrangement, and is far inferior in everything but size to the Providence, or the Lowell Station in Boston, the Broad Street Station in Philadelphia, and many others which might be named.

BUFFALO is one of the cities which are now wrestling with the grade-crossing question. No less than 22 lines enter the city, and it is a necessity for most of them to reach the water front. No definite system has been followed in laying out the roads, and the consequence is that the numerous grade crossings of streets and tracks have become an intolerable nuisance. Some time ago a commission was appointed to prepare a plan for improvements, and to negotiate with the railroad companies for its general adoption by them. The plan which has been prepared by this commission includes a belt line connecting all the roads, a single line into the city and new union passenger and freight stations on a scale large enough to provide sufficient room for the business for years to come. It will not interfere with the lines to the coal docks and elevators on the water front, but it will concentrate in one place the business now done at half a dozen or more different points, and will do away entirely with the numerous grade crossings of streets now existing.

WORK has been begun on the sinking of the track of the New York Central Railroad north of the Harlem River, which is to make a depressed line between five and six miles in length, and to separate the tracks from the street crossings in the same way as was done a number of years ago on the road from the Harlem River to the Grand Central Depot. This work will take some time to complete, as it must be carried on without disturbing or interrupting traffic on the present track. It has been urged upon the company for some time, and has, in fact, been made a necessity by the rapid growth of the section of the city known as the Annexed District.

In this connection it might be suggested that it would be a wise thing for the company to arrange for some other crossing of the Harlem River than the one now in use. The whole passenger business of the Central road is now carried across the Harlem on a bridge, and is subjected to continual and vexatious delays by the opening of the draw for the passage of vessels. These delays necessarily will be very much increased when the improvements of the river are completed, and vessels of large size are enabled to go up the river and pass through the new channel to the Hudson. A high bridge is impossible, but it does seem as if a tunnel under the river could be arranged in connection with the depression of the tracks. Such a work would be expensive, not so much for the tunnel itself as for the approaches which would be needed, but it would probably pay for itself in a short time in the prevention of delays and the freedom from accidents. A collision between a vessel and the draw-span of the present bridge, which is possible, and even probable at any time, would stop the entire traffic of the road for a day or more, causing loss and inconvenience which would be almost incalculable. The whole location of the road from the 125th Street Station to Mott Haven, including the junction between the Harlem Division and the Main Line, is not an example of the engineering which ought to exist on so important a line, and the beginning of the new improvement would seem to be a good time for a general revision of the location and the establishment of a line which would be a credit to the company and its officers.

AN examination of the *Official Guide* for June shows that the fastest trains now on the time-tables are two on the Baltimore & Ohio Railroad, which are timed to run the 40 miles from Baltimore to Washington in 45 minutes, without stops, making the rate of speed 53.3 miles an hour. No other train can be found which makes over 50 miles an hour, and the nearest approach to it is a train on the Pennsylvania Railroad, which runs from Jersey City to Philadelphia, making one stop, at an average speed of 48.3 miles an hour. On the opposition—the Bound Brook—line one train makes the distance from Jersey City to Philadelphia at the rate of 45.9 miles an hour, without allowance for the four stops. The quickest train between Philadelphia and Baltimore runs at the rate of 41.6 miles an hour.

The fastest long-distance run is that of the Chicago Limited on the New York Central & Hudson River Road, which averages 41.6 miles an hour from New York to Albany, and 40.6 miles from Albany to Buffalo. The corresponding train on the Pennsylvania road runs at the rate of 38 miles an hour from Philadelphia to Pittsburgh.

The trains which are timed to run over 40 miles an hour are thus found to be very few in number, and there are not many which are called upon to make more than 35 or, indeed, over 30 miles for any considerable distance. It must be remembered, however, that a train whose average speed is 40 miles an hour must make much faster time than that in parts of its run.

What is the slowest passenger train in the *Guide* is not easy to determine, but an "express" on a North Carolina line, which takes 9 hours to run 100 miles—an average of 11.1 miles an hour—is a very promising candidate for the honor.

THE importance of the coal-mining industry of the United States is shown by the figures for 1887, which have been compiled by Mr. C. A. Ashburner for the United States Geological Survey. The total output of coal last year was 123,965,000 tons, and its value at the mines is estimated at $173,531,000. Almost one-third of the output and more than one-half of the value was furnished by the anthracite mines of Pennsylvania, their product being 39,506,000 tons, valued at $79,365,000. Pennsylvania, indeed, mined more than half the entire amount, its bituminous production being 30,867,000 tons, making with the anthracite a total of 70,373,000 tons. The output of the mines of Ohio was 10,302,000 tons, and of those of Illinois, 10,279,000; no other State produced as much as 5,000,000 tons. Coal was mined in 30 States and Territories, although in nine of them the quantity produced was very small.

THE very unfavorable reports of earnings of railroads now coming from some of the Western and Southwestern railroads show the effects of the over-building of new roads, which has been going on for several years past. Both sections of the country are growing rapidly, and there has been a large increase of traffic, but their business has been so divided up that the new lines have lacked support, and competition has been so sharp that rates have been reduced in many cases to such a point that the traffic will barely pay the expenses of doing it, and will leave nothing for the investors in such lines. Of course this state of things will be partly remedied in time by the growth of the country, but for the competition of parallel lines and the lowering of rates there is not much hope of a remedy.

Experience has shown that in this country it is much easier to reduce rates than to raise them, and, in many cases, the attempt to increase charges to a fair figure has had the effect of arousing enmity against the railroads which has done almost as much harm as the low rates. Competition is an excellent thing in its way, but in the case of many of our railroads it has been carried entirely too far, not only for their own benefit, but for that of the people they serve.

STATE control of railroads, which prevails so extensively on the Continent of Europe, does not appear to meet with much favor in England. It may be remembered that in the General Railroad Act, which was passed by Parliament in 1844, it was provided that the Government might acquire possession of railroads under certain conditions, the provisions being very similar to those embodied in most of the early railroad charters in Massachusetts, New Jersey, and several other States in this country. Recently a motion was made in Parliament for the appointment of a commission to take into consideration the question of "acquiring the railroads of the United Kingdom in accordance with the provisions of the Act of 1844," the mover of the resolution advocating it in an elaborate speech, but it met with so little support that after a brief debate it was negatived without a division.

Incidentally it was said in the debate that the total capital invested in the Kingdom of Great Britain was £830,000,000, and that the average return upon this capital was about 4 per cent. It was also stated that under the present system the interests of English manufacturers were injured by the high charges on the railroads of the country, the average rate per ton-mile in England being more than double that of the United States, very nearly double that of Belgium, 50 per cent. higher than that of Germany, 30 per cent. than those of Holland and Italy, and higher than in any other European country, with the exceptions of France and Sweden. The reasons given for the high freight rates were three: the comparatively short hauls on English railroads, the heavy terminal expenses, and the fact that the railroads in England are owned by private corporations, and are operated entirely for the purpose of making money, and not for the benefit of the people. This last condition, it was argued, might be changed should the Government own the railroads.

As shown by the division, however, the feeling in Parliament was evidently very strongly against any proposition of this kind, and there is no probability that it will be renewed.

The argument that the roads would be operated for the benefit of the people under State ownership does not meet with much support from experience in France and Germany, where complaints are quite as frequent against the State railroads as the private lines. The fact is, that in Europe, as elsewhere, when a man advocates railroad management for the benefit of the people he generally means by "the people" the particular class which he represents. State management has never met with favor in England, although State control has many advocates.

THE Army Appropriation Bill, which is now before the House of Representatives, contains nothing of very special note except an appropriation of $400,000 for the purchase of dynamite guns, and another of $100,000 for the examination and testing high power shells and explosives. These appropriations have been added in committee, and are in addition to the amount authorized for new ordinance of which we have already spoken.

THE Navy is to have some more new ships, if the appropriation bill passes Congress as reported by the Naval Committee. The bill contains appropriations and authority for letting contracts for four new ships in all, two unarmored cruisers of about 3,000 tons displacement, and of guaranteed speed of not less than 19 knots; one unarmored cruiser of about 5,000 tons to be guaranteed 20 knots; and one heavily armored ship of 7,500 tons displacement, to be capable of making about 17 knots an hour. The bill provides that one of the vessels must be

built in a navy yard, and all of them may be, if the President should so direct. Three of the new vessels authorized are of the class which is likely to be of the greatest use to our Navy.

Fair progress is being made with the new guns for the Navy, as will be seen from the notes printed on another page.

THE contest between armor-plates and projectiles has been renewed abroad, and some recent experiments with steel and composite plates made in England, seem to indicate that for the present the projectiles have the worst of it. On the other hand, it is announced that the Krupp Company is now building at Essen the largest gun yet made; it is for the Italian armor-clad *Sardegna*, and will weigh 139 tons, will be 52½ ft. long, and have a bore of 15.7 in. This gun will, it is stated, fire a steel shell weighing 1,630 lbs. with an initial velocity of 2,630 ft. per second, or a heavier shell of 2,300 lbs. with an initial velocity of 2,100 ft. It is expected by the makers that this projectile will be able to knock out of time any armor-plate now afloat, and that there will then devolve upon the other side the problem of building a vessel which can float armor-plates heavy enough to resist these shells.

Hudson River Passenger Business.

IN the competition between the railroads and the water routes for business in this country the railroads, so far, have had decidedly the best of it, at any rate so far as passenger business is concerned. The Mississippi, the Ohio, the lower Missouri, and many other Western rivers are now more or less closely paralleled by railroad lines, and the river passenger trade has practically fallen away to almost nothing; and the same is the case on many of our Eastern rivers, where the steamboat lines formerly had a considerable business.

The Hudson River is naturally the finest river for passenger travel in the world, but the railroads on either bank have taken away the larger share of the traffic which it ought to carry. The better time which they are able to make for long distances has had at least something to do with this, while for through travel the avoidance of a break or transfer in the course of the journey has also assisted the railroad competition. Nevertheless, there is still a very large passenger business carried between New York, Albany, and the towns and cities on the upper part of the river by the numerous lines, and their flourishing condition shows that the steamboat business is not an unprofitable one. On the lower portion of the river, however, from Newburgh down, the river passenger business has practically disappeared, and the number of travelers, excepting excursionists, who take the boats there is insignificant; substantially all the business from the towns on either side going to and from New York by rail.

It is impossible to resist the belief that this has been largely the result of mismanagement. From New York to and through the Highlands the river is closely dotted on both banks with flourishing towns and villages, having a large population in close connection—many of them daily travelers to and fro—with the City, and for one-half of the year this population is fully doubled by summer residents. To many of these people the steamboat trip would be far preferable to that by rail, were there any comparison between the time and the conveniences afforded for travel.

It would seem as if the steamboat men had deliberately thrown this business away by their obstinate adherence to old methods. The boats which have been employed in the business have been nearly all of them of old style and inconvenient, and no effort seems to have been made to replace them by better ones, while the running schedules have been more in accordance with the needs and the habits of 25 years ago than the present time. It seems as though they had deliberately abandoned the field to the railroads without one single effective effort at competition.

On a river so wide as the lower Hudson, a boat making landings on both sides must necessarily lose a great deal of time, and the loss is largely increased by the changes and chances of wind and tide. Nevertheless the steamboat men have gone on making the landings in this way with their unwieldy boats, and have been apparently surprised when they found that people would not travel by them because they took too long to make the trips.

It would seem as if there was now on the Hudson River a field well worth cultivation. Fast boats with modern machinery, which could be economically managed, making landings on one side of the river only, and not making too many, would be able to reach almost the time of a way train, either on the Hudson River or the West Shore road. The boats should be small enough to be able to pick up a living business from a few landings, and so could avoid the delays consequent upon taking in all the villages. They could be very economically run, would cost less both to build and to work than the old style boats, and could, at a reasonable expense, be made very attractive to passengers. On the Hudson River below the Highlands a boat can be run for eight months in the year, and for six months of that time the travel is large, so that the amount lost in interest, etc., while the boat is laid up for the winter, would be comparatively small.

It would seem hardly an open question that one or two such lines once established would be so profitable that they would soon be followed by others, and that in a few years, by proper management, not only would a large proportion of the business once done on the river be restored to it, but an important addition would be made to the prosperity and the population of the river towns and villages, which are not now, as a rule, growing as fast as some other much less attractive regions within an equal distance from New York; so that an apparent temporary loss to the railroads might be followed by a permanent gain to all.

National Railroad Reports.

IN a circular which is given on another page, the Interstate Commerce Commissioners announce their intention of carrying out that clause of the law which empowers them to require from the railroad companies reports in relation to their business and financial condition. The object of the law is that information so obtained may be properly arranged and tabulated, and may then be used by the Commissioners for their own information, or for the instruction of Congress in preparing further legislation. The Commissioners have prepared a form of report which they expect to send to every railroad company in the United States, whether its line is wholly within one

State, and thus beyond their immediate jurisdiction, or whether it is actually an interstate line, with the expectation that all of them will give the information desired, without raising the point as to whether they come within the operation of the law.

The Commissioners hope in this way to secure a body of statistics in relation to all the railroads in the United States, which shall be put in uniform shape, and which shall have the value which attaches to statements officially made and vouched for. Their object is an excellent one, and if it is properly carried out it will furnish a mass of information about the railroads of this country, such as has never been collected up to the present time. The reports which the great majority of railroad companies make have hitherto been entirely voluntary. In some of the States they are required to make yearly returns to railroad commissioners; in Massachusetts the Commission some years ago finally adopted a very excellent form for these returns, the answers to their questions necessarily showing in an intelligible form the real financial condition and the course of business of every railroad in the State. Two or three other States have adopted substantially the Massachusetts form, but in all the others in which reports are required they are made in such a loose and imperfect shape as to have no practical value.

Beyond this there may be said to be no official statements of railroad business in this country. *Poor's Manual*, great as its value is to owners of railroad property or to would-be investors, is not an official publication, and its compilers are necessarily obliged to obtain their facts from railroad companies, and to take such information as their officers may choose to give, without the opportunity or the ability to verify these statements. A considerable number of companies publish annual reports, which are issued to their stockholders; but, unfortunately, it is only too evident to any one familiar with the subject that many of these reports either give very little information, or are—sometimes by intention, more often through inexpertness of the compilers—so misleading in their statements that their value is very small. A few companies—such as the Pennsylvania, the Union Pacific, under the present management, and some others which follow in their footsteps—send out reports which are models, but in other cases the real condition of the company is so covered up by a mass of confusing details that no one but an expert accountant can understand them, and to the average stockholder they are about as much use as a Greek manuscript would be.

To the person who is not interested in any particular road, but who desires to make a general study of the business of the country, such reports as these of individual companies, even the best, are of use only as indications of the general drift of things, and he has heretofore been obliged to give up the subject in despair, or to content himself with such approximations to the truth as he may be able to reach by a laborious system of reasoning, inference, and guesswork.

The condition of railroad statistics of this country can be best expressed by noting that the publishers of a popular magazine recently issued a little card containing 20 questions in relation to railroads; to at least half of these questions there is no living man who can pretend to give accurate answers, and the replies, which the publishers have gathered from some of the best informed men in the country, are merely approximations.

It is not to be expected that the labors of the Interstate Commerce Commission can remedy this state of things in one year or two, but the collection of official reports on a uniform plan for the whole country will be a great step in advance. It is to be hoped that the railroad managers will recognize the fact that it is to their own interests to make such statements as complete as possible, so that in the course of a few years it will be possible to obtain for the first time correct and comprehensive statements of the entire railroad business of the United States.

HALF A CENTURY AGO.

JUST one-half a century ago, in 1838—when the JOURNAL was six years old—a census of all the steam-engines of every description in the United States was taken. This work was done in pursuance of a resolution of Congress, the object apparently being to secure information upon which could be based a law for the regulation of the use of steam; and it was, in fact, shortly after that time that the first general law in relation to steamboats was passed. The census was taken by the collectors of customs in the different districts, and appears from the report which was submitted to Congress, a copy of which is now in our possession, to have been pretty carefully done. It is curious to look over the figures now, and to contrast them with some of those for the present year.

In his preliminary statement the Secretary of the Treasury says that full reports have been received from all the States except Mississippi and Tennessee, in which two or three districts were missing; and that they were somewhat imperfect from the States of Illinois and Arkansas and the Territories of Wisconsin and Iowa. An estimate is made, which is probably a pretty close one, for the missing districts, in several of which it is considered that the absence of returns was due to the fact that there was nothing to return; that is, that there were no steam-engines there.

The summary, including estimates, informs us that there were then in the United States 800 steamboats, 350 locomotives, and 1,860 stationary steam-engines, but these were very unevenly distributed. The largest number of the stationary engines in any one State was in Pennsylvania, where 383 were found, some of them in factories, but a considerable number employed as hoisting and pumping engines in the coal mines, which were already beginning to be an important industry. Curiously enough, Louisiana stood second among the States in her stationary engines, having not less than 274, or about one-sixth of the whole number in the United States. At first sight it appears strange that a State which has never been noted for its manufactories should have had—at that early day—so many engines, but this may be explained by two causes: one, that a large number of small engines were employed on the numerous sugar plantations of the State for crushing cane and similar purposes, and another being that in so level a region there is almost an entire absence of falls which can be utilized for water-power. Thus in Massachusetts, which was considered at that time the leading manufacturing State, there were only found 165 stationary engines; but this is not surprising when we remember that a large proportion of the mills were run by water-power. New York was fourth on the list, having 87, while Ohio already had no less than 83.

The number of steamboats in service, as already stated, was 800. Nearly all of these were employed in river and inland navigation, very few being sea-going vessels or, at least, employed on ocean routes. Not one of the number had crossed the Atlantic, but in New York five were registered as plying between that port and Wilmington, Charleston, Texas, New Orleans and Natchez; the last, by the way, would be considered rather an unusual route for a steamer nowadays. In Philadelphia there were four steam vessels which ran between that place, Wilmington and Charleston; in Baltimore two were owned, forming a line to Charleston and Savannah; two coasting steamers were owned at Wilmington, N. C., and two at Charleston.

The Secretary expressed considerable surprise at this, in consideration of the fact that the first steamship—the *Savannah*—which ever crossed the Atlantic had been built in New York 19 years before, and that the voyage had been successfully made by other steam vessels since that time. The *Sirius*, in fact, had opened the first steamship line between New York and Liverpool, and was soon to be followed by the *Great Western*.

The United States Government at that date owned one sea-going war steamer, the *Fulton*; it also owned 13 steamboats employed in the service of the various departments.

In the number of steamboats New York led all the States, having 140 reported; the larger number of these were returned from New York City, and were employed on the Hudson River, Long Island Sound, and the adjacent waters, though already a considerable number of lake steamers were registered at Buffalo. Pennsylvania came second with 134 steamers, a few being owned in Philadelphia and two or three at Erie, but the majority belonging in the Pittsburgh District and being employed on the Ohio and Mississippi and their tributaries. Ohio was the third State in the number of steamers, owning 79, and 41 belonged in Kentucky, no other State possessing an equal number.

The largest steamboats then owned in the United States, which are mentioned in the report, are the *Natchez* of 860 tons measurement and 300 H.P., which was employed on the route from New York to Natchez mentioned above; the *Illinois* of 755 tons and the *Madison* of 700 on Lake Erie; the *Massachusetts* of 626 tons plying on Long Island Sound. These are small vessels compared to the great lake and river steamers of the present day.

Then, as now, the chief source of accidents on steamboats seems to have been either the defective construction of boilers or the tendency to work them too hard. The accidents mentioned in the reports are nearly all from boiler explosions, and the legislation proposed or at least recommended by the Secretary related almost entirely to the care of the boilers, the regulation of the material to be used and the pressure to be employed, with provision for frequent inspection.

The most interesting part of the report to us, however, is that which enumerates the number of locomotives, of which there were 350 reported. More than one-quarter of these were in Pennsylvania, and were used on the short coal roads in the eastern part of that State, although a considerable number were on the road from Philadelphia to Columbia and on the Reading road. The Portage Railroad crossing the Alleghanies was operated by stationary engines hauling the cars up inclined planes. Massachusetts came second with 37 locomotives; Virginia, third, with 34; New Jersey, fourth, with 32—most of them on the Camden & Amboy; Maryland, fifth, with 31, nearly all Baltimore & Ohio engines; New York, sixth, with only 28, and South Carolina, seventh, with 27. No other State had then more than 10 locomotives owned within its limits. The engines in New York were on the Long Island and Harlem roads—then the only lines running out of New York City—and on the Mohawk & Hudson and the other short lines running westward from Albany, which now form part of the New York Central.

These 350 engines were employed on 1,500 miles of road, and form a very striking contrast to the 29,500, the estimated number in the United States at the beginning of the present year.

It might be curious to note, however, that the number of locomotives has really increased very little faster than the mileage of railroads. In 1838 the average number was one to 4¼ miles of railroad, while in 1888 it is only a very small fraction over one to 4½ miles. This, however, does not make any allowance for the increased power of the average locomotive of to-day over that of the engines employed 50 years ago.

In relation to locomotives, this old report is not as full as might be desired; this is, perhaps, to be expected, as the information called for related chiefly to steamboats, and the regulation of Interstate Commerce other than that by water was not then the pressing question which in these later years the development of railroads has made it.

Very little information is given as to the size of the locomotives, although in some cases their horse-power is enumerated, which is, however, rather an indefinite guide. The largest given were rated at from 20 to 25 H.P., although a few on the Boston & Providence and the Boston & Worcester ran as high as 30. The New York railroads did not require so much power apparently, for the heaviest locomotive given on any of them was rated at 20 H.P.

Some of the locomotives were built in England, but the majority at that time were of American manufacture. The firms of Baldwin and Norris, in Philadelphia, had already begun to make a name; the Locks & Canals Company in Lowell was engaged also in the building of locomotives, and a number of other makers appear in the list given—as Garret & Eastwick, Philadelphia, the New Castle Company, Bolton & Company, and one or two firms in Boston which have either ceased to exist or have gone out of the locomotive business.

Some attempt appears to have been made to collect statistics in relation to accidents on railroads, but it was so slight and the results were so imperfect as to be hardly worth recalling. Two accidents, it is stated in the report, had occurred up to that date from the explosion of locomotive boilers, and other accidents are referred to incidentally, but not described.

Although no direct statement to that effect is made in the report, it is very evident from its general tone, and from many indirect references made in it, that while much interest was felt in railroads, they were regarded then as entirely subordinate and inferior in importance to steamboats and river navigation. The steamboat was the great vehicle of commerce wherever it could be used, and the railroad, like the highway road, was useful chiefly as an auxiliary or feeder to the water lines. No one then anticipated to what an extent the railroads would take business away from the steamboats, and the prophet who then predicted the construction and successful working of rail-

roads parallel to such highways as the Hudson or the Mississippi would have had very little credit in his own country —or elsewhere.

NEW PUBLICATIONS.

TABLES FOR FIELD ENGINEERS, DESIGNED FOR USE IN THE FIELD: BY AMOS STILES, C.E. New York; published by D. Van Nostrand (price, $2).

This volume contains three series of tables, the first giving radii and their logarithms, tangential offsets, and middle ordinates; the second containing chords, versed sines, external secants, and tangents of a 1° curve for every minute of angle from 0′ to 90°; the third giving natural sines and tangents to every degree and minute of the quadrant.

These tables are preceded by general explanations and a number of problems showing the uses to which they may be applied in field and locating work. These problems are briefly stated, and the application of the tables shown without any attempt at mathematical demonstration, which would, indeed, be hardly possible within the limits of the book.

The Author says: "It has been our endeavor to set forth with clearness some of the abridged methods found so convenient and easy in connection with the building of some of the most extensive railroads in America."

The book is bound in pocket-book form, and is of convenient size; it will be a welcome addition to the outfit of the engineer in the field.

TABLES OF THE PROPERTIES OF SATURATED STEAM AND OTHER VAPORS: BY CECIL H. PEABODY, B.S., ASSISTANT PROFESSOR OF STEAM ENGINEERING IN THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. New York; published by John Wiley & Sons (price, $1).

These tables were prepared by Professor Peabody chiefly for the use of students in technical schools, but they are of value for engineers also. For saturated steam three tables are given, one in English units for each degree Fahrenheit; one in English units for each pound pressure, and one in French units for each degree Centigrade.

Besides the tables for steam, tables are given of the properties of saturated vapors of alcohol, ether, chloroform, carbon bisulphide, carbon tetrachloride, and acetone. These tables are all given in French units, and are based on Regnault's experiments. In addition, approximate tables are given of the properties of saturated sulphur, dioxide, and ammonia.

An introduction to the tables gives the original data of Regnault's experiments on the properties of saturated steam, and of Rowland's experiments on the mechanical equivalent of heat and the specific heat of water, with the formulæ derived from those experiments.

All of the tabular values given in the book were calculated directly by the aid of these formulæ, without approximation, and have been carried to as many places of significant figures as the data given would warrant. These original calculations were all checked by the method of differences.

The amount of labor involved in the preparation of these tables must have been very great, and will be appreciated by those who have occasion to use them.

ABOUT BOOKS AND PERIODICALS.

THE second article of the Railroad Series, entitled Feats of Railway Engineering, by John Bogart, State Engineer of New York, appears in the July number of SCRIBNER'S MAGAZINE. Mr. Bogart, who is especially well fitted to write on this subject, describes with great force the building of such extraordinary works as the St. Gothard spiral tunnels, the wonderful combination of bridges and tunnels on the Oroya Railroad in Peru, the Niagara and the Britannia bridges, and many other wonderful achievements.

Instead of a lack of material, the writer has had a great superfluity, and has had to use his judgment in selecting such as would be of the greatest interest and profit to the reader.

He describes the Brooklyn, the Kentucky River, the Harlem, the Bismarck, the Niagara, the St. Louis, the Lachine, and the Forth bridges, and the St. Gothard, the Mont Cenis, and the Hoosac tunnels—noted chiefly on account of their great length. One of the most striking examples of bridge construction is the iron Portage Bridge, which takes the place of the old wooden one destroyed by fire, the two examples of iron and wooden construction being shown in the engravings. The old Portage Bridge, by the way, was in itself a great engineering feat, being the most daring example of wooden bridge construction ever undertaken.

A full description is given of the cork-screw tunnel on the St. Gothard Railroad, where, in order to overcome the ascent required, it was found necessary to secure a much longer distance than a straight line or an ordinary curve would give the line, and it was therefore doubly curved upon itself.

The remarkable series of articles on Siberia which are now running in the CENTURY MAGAZINE have, apart from their political bearing, much interest as showing incidentally the material resources of Siberia, and the progress which has been made toward their development. Siberia is, to most of us in this country, merely a name for a cold and barren region only fitted for a penal colony; the truth concerning its great agricultural and mineral resources has been known to very few, and the facts given in these articles are a general surprise. The Southern Siberian line, which is to extend across Asia to the Amoor settlements and the Pacific Coast, will open up some of the richest country yet undeveloped in the world, and any information about it is of interest.

The NORTHWESTERN RAILROADER showed a very creditable spirit of enterprise in moving its headquarters from Minneapolis to Alexandria Bay, and publishing a daily edition during the sessions of the Master Car-Builders' and the Master Mechanics' conventions. The edition contained a report of the proceedings each day, and was out in very good time.

THE POPULAR SCIENCE MONTHLY for July contains an article on Safety in House Drainage which is worthy of a careful reading. The writer seeks to show that there are methods by which all danger to health can be obviated in the plumbing and drainage of dwelling-houses. This is not altogether in accordance with the general belief, but the article makes a strong showing for the other side,

BOOKS RECEIVED.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1887. TENTH NUMBER: FINANCE, COINAGE, COMMERCE, IMMIGRATION, SHIPPING, POSTAL SERVICE, POPULATION, RAILROADS, AGRICULTURE, ETC. PREPARED BY THE BUREAU OF STATISTICS UNDER THE DIRECTION OF THE SECRETARY OF THE TREASURY. Washington; Government Printing Office.

LAND LAWS AND DECISIONS, WITH A REVIEW OF SOME RECENT DECISIONS OF THE SUPREME COURT OF MICHIGAN: BY F. HODGMAN. Climax, Mich.; published by F. Hodgman (25 cents). This is a report made to the Michigan Engineering Society by its Secretary.

DAS NEUE TACHEOMETER, EIN UNIVERSAL-INSTRUMENT FÜR ALLE FELDARBEITEN DES INGENIEURS: VON FRANZ KREUTER. Brunn, Austria; published by Karl Winiker.

SOME POINTS RELATING TO THE EFFICIENCY OF MECHANICAL ENGINEERING SCHOOLS: BY ALFRED R. WOLFF, M.E. Hoboken, N. J.; issued by the *Stevens Indicator*. This is a reprint of the Presidential Address delivered before the Alumni Association of the Stevens Institute of Technology at its last meeting.

SELECTED PAPERS OF THE CIVIL ENGINEERS' CLUB OF THE UNIVERSITY OF ILLINOIS, 1887–88. Champaign, Ill.; issued by the Club; H. Dunaway, Secretary.

WORLD-ENGLISH: THE UNIVERSAL LANGUAGE: BY ALEXANDER MELVILLE BELL. New York; published by N. D. C. Hodges. London; Trübner & Co.

STATE UNIVERSITY OF IOWA: CATALOGUE FOR THE YEAR 1888–89. Iowa City, Ia.; published by the University. This Catalogue shows the University to be in a flourishing condition.

REVISTA DE OBRAS PUBLICAS E MINAS: ASSOCIACAO DOS ENGENHEIROS CIVIS PORTUGUEZES: TOMO XIX. Lisbon, Portugal; published by the Imprensa Nacional.

THE EDSON PRESSURE RECORDING GAUGE AND HIGH-PRESSURE ALARM: THE EDSON TIME AND SPEED RECORDER. CATALOGUE. New York; Jarvis B. Edson, No. 86 Liberty Street.

STORAGE BATTERIES: CATALOGUE AND DESCRIPTION. New York; issued by the Gibson Electric Company, No. 775 Greenwich Street.

THE CENTRAL PACIFIC RAILROAD: ITS RELATIONS WITH THE GOVERNMENT. This is a reprint of the argument made by Mr. Creed Haymond, General Solicitor of the Central Pacific Company, before the Select Committee of the United States Senate, in March and April last.

Hypercycloidal Gear.

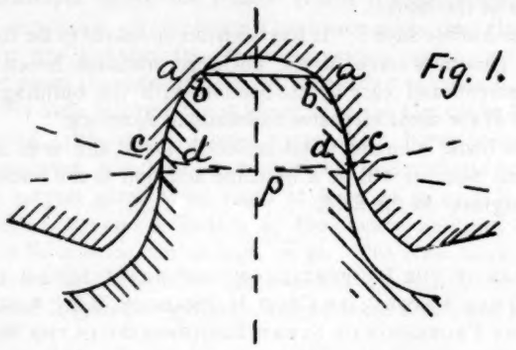
To the Editor of The Railroad and Engineering Journal:

IN your JOURNAL for April of this year, I notice an article on "Hypercycloidal Gear," which makes some astonishing claims for teeth generated in a very strange and indefinite manner. The curve used is said to be "one of the cycloidæ, but to describe it in the ordinary manner, the scribing point is made to project beyond the rolling or generating circle, and the curve is scribed across the generatrix or pitch line." This may be all right in a general way, but there is no information given as to what rolling circles are actually used or the exact location of the scribing point in forming the teeth referred to, and the reader is at first in doubt as to whether the Author knows more than he wants to tell, or less than he tries to.

If any point projecting to any extent beyond any rolling circle will produce the mysterious form desired, it naturally follows that the involute and cycloidal teeth in common use are nothing more than special forms of a more general type. But the characteristics stated for the general type cannot be conceded to exist in the special forms mentioned, nor in any other forms whatever, and the question naturally arises—can they be true?

Can a tooth which fits its engaging space as shown in fig. 1 be considered as an admissible form for correct gearing, and, if so, is it possible to apply the same form to wheels of any number of teeth?

To answer this question, we have only to consider that one of the first principles of correct gearing requires that a normal to the surfaces in contact shall always pass through the pitch point *p*. This condition is necessary to insure a constant velocity-ratio between the engaging wheels, and if a normal to every part of the curve *a c* passes through the pitch point *p*, it follows that the curve *a c* must be the arc of a circle struck from the center *p*.



Now, as the wheels move in either direction from the position shown in fig. 1, the centers for the arcs *a c* and *b d* must separate, and there cannot be a common normal to these arcs; from which it is evident that the velocity-ratio must vary, and that the continuance of large bearing surfaces is impossible.

On the other hand, if the curve *a c* is not a circular arc, and it really seems to be nothing more nor less than a clearance curve traced by the point *b*, the velocity-ratio of the engaging wheels must have innumerably different values at the same time, which is absurd, and, in either case, whether the curve *a c* is a circular arc or not, the claim that the teeth fit together on the line of centers as shown, condemns them absolutely.

Such teeth are simply corrugations unworthy to be mentioned among the refinements of modern practice, and the more thoroughly they are weeded out the better.

It is, of course, possible for such gears to run together, but their action is far from perfect, and I know from experience with them something about the intolerable noise that they make while running.

It would be very nice, indeed, if one cutter could be used successfully on all wheels of the same pitch, but when this is done properly, it is very certain that the method used will be such as to cut a different shape for every different number of teeth, and I venture to predict that whatever forms of teeth may be favored by engineers, the hypercycloidal will never find a place among them.

Philadelphia, May 21. WILFRED LEWIS.

THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

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(*Continued from page 254.*)

CHAPTER XXV.

RULING GRADE.

By the Ruling Grade of a road is meant that grade which limits the length and weight of the train that can be hauled over that road or section. In the case of the ruling grade, it is the rate of grade and the length that should be considered and studied, and not the actual rise in feet.

The ruling grade, however, is not in all cases the steepest grade on the road, for the reason that the steepest grade may either be so short or so located in reference to the preceding grade that heavier trains may be able to surmount it by means of acquired momentum than some other grade of less rate but longer or less fortunately situated. Thus, in Plate XLVII, fig. 1, the rate of the grade *f g* is much less than *c d*, still *f g* would be the ruling grade.

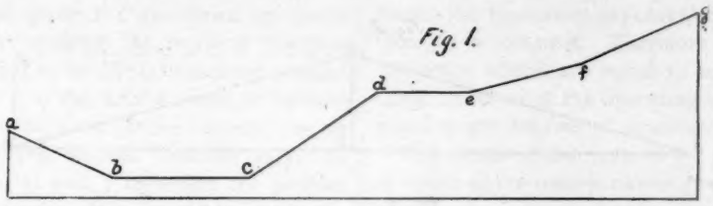
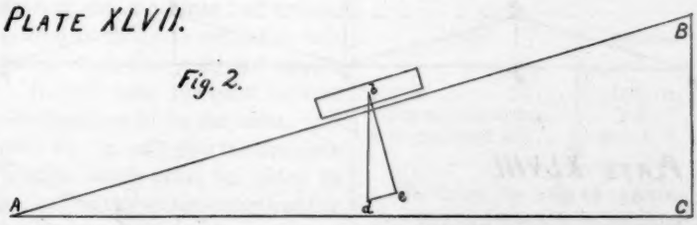


PLATE XLVII.



Any train to surmount *c d* would be able to get a run at it down *a b*, and be able to surmount it by means of the momentum thus acquired. In the case of *f g* the approaching grade *e f* would do away with the possibility of acquiring any surplus momentum. Or, to take another case, the steeper grade may be opposed to the lighter traffic, and thus one much less steep, but opposed to the heavier traffic, may become the ruling grade.

But, other things being equal, when the ruling grade is so situated that it can be surmounted by momentum it is practically reduced by the amount that can be gained by this acquired momentum, and the virtual ruling grade as affecting the weight and length of the trains would be the actual grade on the ground, less the grade that could be surmounted solely by the momentum acquired. This subject of virtual grades will be more fully explained farther on, but for the present purposes the ruling grade of a road is the steepest virtual grade, and the effect of this grade as a ruling grade is due to the rate of grade and to its length, while on minor grades, that is, grades that are less than the ruling grade, their bad effect is due, not to the rate of the grade, but to the actual amount of rise and fall. As a basis for the comparison of the cost of running the trains, or the operating expenses of the railroad, we will take the cost per train-mile, that is, the average cost of running the average train one mile, and this has been found to be $1 more or less.

The Train-Mileage of a road would be the sum of the product of the number of trains run by the number of miles run by each. This cost per train-mile, of course, will vary in each particular case, depending upon the alignment and condition of the road, the class and amount of traffic, and the regularity with which it comes to the railroad. That is, whether about an equal amount has to be hauled each month, thus keeping a minimum amount of rolling stock fully occupied, or whether the bulk of the traffic comes with a rush in certain months of the year, so that a large amount of rolling stock is then needed, while comparatively little traffic is done the remainder of the year. Of course, in this latter case the average cost per train-mile would be much greater, if the interest on the investment be taken into account, as it should be.

When the bulk of traffic is in such freight as coal, minerals, slate, or anything with which the cars can be fully loaded, the ratio of the cost per train-mile to the gross earnings per train-mile is much less than in the case of miscellaneous freight, as the ratio of paying to non-paying load hauled is much less. The direction of the traffic—that is, the amount going in either direction over the road—also has a great effect on this ratio.

From these and various other causes too numerous to mention, the cost per train-mile varies in each particular case, but the average for the principal roads of the United States can be fairly taken to be $1 per train-mile. On a road not yet built, it is, of course, extremely difficult to calculate with any degree of exactness what the future cost per train-mile will be, or how many daily trains will be run. By the number of daily trains is meant how many trains run over the road one way in one day, as every train that goes out is supposed to return. The only way is to find out what it is upon a line situated as nearly similar as possible. In cases where changes are to be made in location of a line of road that is already built and in operation, it is comparatively an easy matter to find the exact cost per train-mile, and thus the exact value of the proposed improvements, or rather the maximum amount that can economically be spent upon them.

We have stated that the resistance to the movement of a train upon a straight, level track at an average speed is about 9.3 pounds per ton of weight hauled. Or it may be

found for any speed by the following formula of D. K. Clark's :

$$R = \frac{v^2}{171} + 8$$

R = Resistance in pounds per ton of 2,240 pounds.
v = Speed in miles per hour.

Where R = Resistance in pounds per ton of 2,000 pounds the formula will be :

$$R = \frac{v^2}{200} + 7.3$$

This formula is the one most generally used in this country, and, considering the number of variables which enter into any calculations of this question, probably gives results as correct as many more elaborate ones, and certainly has the advantage of great simplicity and ease of application.

To find the resistance opposed to the movement of a train by a grade we have simply the following problem in mechanics : Given a weight and a certain inclined plane to find the amount of power applied to the weight, parallel to the inclined plane, which will just move the weight, all friction being left out of the question, as this friction is what is overcome in moving a train upon a level track.

In Plate XLVII, fig. 2, let $A\ B\ C$ be the inclined plane and W the weight. Then draw $b\ d$ vertical and equal to the weight, and complete the triangle $d\ e\ b$, making $b\ e$ perpendicular to the plane and $d\ e$ parallel to it. Then will $d\ e$ represent the required force, or the resistance to motion up the incline due to the incline solely. And from similar triangles we have $d\ e = \frac{C\ B \times b\ d}{A\ C}$ or the resistance due to the grade = weight multiplied by the rise of the incline, divided by the length. On railroads the angle of the grade with the horizontal is so slight, even on the steepest grades, that in the above triangle, as applied to grades, $A\ C$ is always taken as equal to $A\ B$.

Taking these two equations we find that a grade of 24.5 ft. to the mile doubles the resistance opposed to the movement of a train that is met with on a level, straight track at a speed of 20 miles an hour. That is, it requires twice as much power to haul a train up a grade one mile long with a vertical rise of 24.5 ft. as it does to haul it on the level, straight track. Now, as we have seen, it is of no consequence what the *rate* of grade is when it is not the *ruling* grade, but simply the actual vertical height that affects the resistance opposed to the movement of a train. We have, in terms of the amount of power developed, a vertical rise of 24.5 ft. equal to one mile of distance. In order to shorten and simplify the calculations we will call it 25 ft., which is probably nearer the correct amount. Therefore each 25 ft. of vertical rise in a railroad, no matter at what rate the rise is made (always provided it is not the ruling grade and is within reasonable limits), requires as much extra power to surmount it at a speed of about 20 miles an hour as would haul the same train one mile on a level, straight track. This is the amount of extra power required ; but the increase in the expenses required by the development of this extra power is not in the same proportion as the increase in the power developed. In other

Fig. 1.

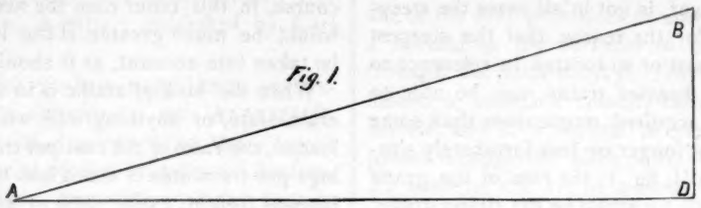


Fig. 2.

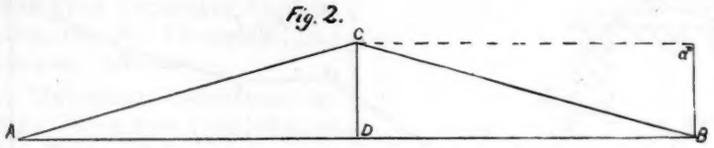


Fig. 3.

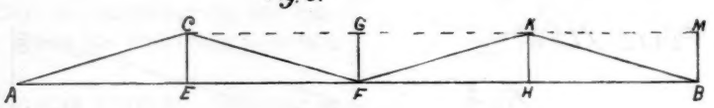
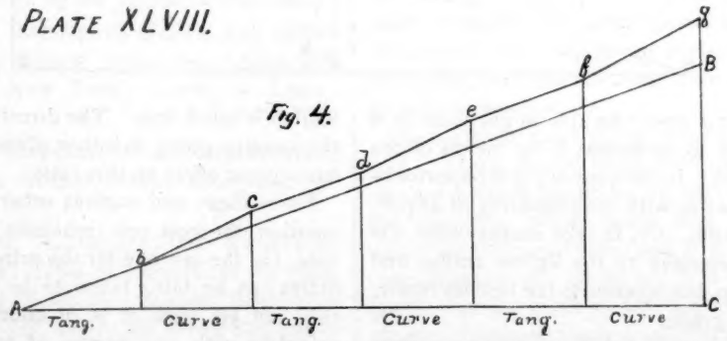


PLATE XLVIII.

Fig. 4.



words, when the amount of power exerted by the locomotive is doubled, the expenses are not doubled, but are only increased in a very slight degree. A careful examination of the data obtained from various roads shows that when the amount of power exerted is doubled the operating expenses are only increased about one-sixth and therefore the number of feet of vertical rise required to double the operating expenses is $25 \times 6 = 150$, or, we may say, each 150 ft. of vertical rise increases the cost of operating by the amount required to move a train one mile on a straight, level track. In other words, 150 ft. of vertical rise and fall is equal to one mile of distance.

By the "operating expenses," as used above, we mean that part of the total operating expenses of the road which is affected by these slight differences in length, and which, we shall see farther on, amounts to about one-half only of the total operating expenses.

In considering the grade of a railroad as affecting the movement of trains, we consider that every train runs the whole length of the road and returns, and therefore passes over every foot of up or down grade twice. Thus, in Plate XLVIII, fig. 2, let *A C B* represent the profile of a railroad between *A* and *B*. Then any train moving from *A* to *B* and return passes up the grade *A C* and down the grade *C B* in going, and up the grade *B C* and down the grade *C A* in returning; thus making the vertical distance through which the train has to be lifted, in making a round trip, equal to $C D + B d'$; or the total amount of vertical rise and fall in the road is the sum of the vertical rise or fall of each grade considered in one direction only. In Plate XLVIII let figs. 1, 2, and 3 represent the profiles of three different roads of which it is desired to obtain the vertical rise and fall as affecting the movement of trains. Commencing with fig. 1, the total vertical rise and fall equals *B D*. In fig. 2 it equals $B d' + C D$, and in fig. 3 it equals $C E + F G + H K + M B$. In this case the total vertical rise and fall of each of these lines would be the same, and this total rise and fall, divided by 150, will give the distance in miles, and fractions of a mile, which must be added to the actual length of the line to give the virtual length of the line in regard to grades, and in terms of the operating expenses; or, in other words, it would cost the same to run the same train at the same speed over a level road whose length was equal to the length of the actual road plus the total number of feet of rise and fall divided by 150, as it would over the actual road with its broken profile. We now know the value in horizontal distance of each foot of vertical rise and fall in a railroad line in terms of the operating expenses, and the next point is to find the value in horizontal distance of each degree of curvature in terms of the operating expenses.

We will assume that the resistance due to curvature varies inversely as the length of the radius, or directly as the number of degrees in the central angle. This, of course, is only correct theoretically, but for making any general rule that shall be approximately correct it is the only basis upon which we can go. It has been ascertained, as near as may be, that a curve one mile long, with a radius of 506 ft., presents a resistance to the movement of a train equal to one mile of straight, level track, or that double the amount of power is required to haul an average train at about 20 miles an hour over one mile of curve, of 506 ft. radius, as upon a straight, level track. A curve one mile long with a radius of only 506 ft. contains 600 degrees of curvature or 600 degrees of central angle. Therefore, in terms of the amount of power developed, 600 degrees of curvature equals one mile of distance. It must always be remembered that all these calculations are made for an average train running at about 20 miles per hour, where the resistance to movement on a straight track is about 9.3 pounds per ton of 2,000. For the reason that the resistance on a straight, level track increases as the square of the velocity the radius of the curve one mile long, which shall double the resistance, varies inversely as this resistance on the straight, level track. Thus, at a speed of 46 miles per hour it would require a curve one mile long with a radius of 253 ft., or 1,200 degrees of curvature, to double the resistance.

But at the rate of speed we have assumed as the average rate—20 miles per hour—600 degrees of curvature are equal to one mile of distance, in terms of the amount of motive power developed. In doubling the amount of motive power, however, as we have already said, we do not double the cost of running the train. The increased amount of operating expenses due to overcoming the resistance encountered on 600 degrees of curvature, or a resistance equal to that encountered on one mile of level, straight track, has been found to be about one-third of the whole operating expenses per train-mile, or about two-thirds the operating expenses that are affected by slight changes in distance. Therefore the number of degrees of curvature which are equal to one mile of straight, level track, in terms of the operating expenses, is $600 \times \frac{3}{2}$, or is equal to 900 degrees of curvature.

The values of the items in the following table are given in terms of the motive power developed or resistance overcome:

Items.	Distance.	Curvature.	Rise and fall.
1 mile	5280 ft.	600 degrees.	25 ft.
1 degree curvature...	8.8 "	1 "	0.041 "
1 ft. rise and fall	211.2 "	24 "	1 "

We know the cost of running an average train one mile. The next question is to examine the items of expense which go to make up this cost of $1 per train-mile, and see how these items are affected by each additional mile run. The items which make up this $1 per train-mile are as follows:

- Motive Power.
  - Oil,
  - Fuel,
  - Waste,
  - Water,
  - Engineer,
  - Fireman,
  - Cleaning,
  - Repairs.
- Train expenses.
  - Train hands,
  - Repairs of cars,
  - Renewals.
- Road repairs.
  - Track,
  - Road-bed,
  - Structures.
- General.
  - Station,
  - Terminal,
  - Taxes,
  - Repairs,
  - Renewals.

These, in general terms, are the items which go to make up the cost per train-mile. It is evident by inspection that very many of these items are not in the slightest degree

affected by slight changes in distance such as we are now considering. The items which are most affected are the repairs to locomotives and cars, fuel and maintenance of way; but even these do not vary directly as the distance, but are only increased about 75 per cent. for each additional train-mile, and this would increase the cost per train-mile about 50 per cent. or 50 cents, so that every train run one extra mile would cost the road 50 cents. Now if there is to be a train each way over the road every day, with the exception of Sundays, and, with the usual number of extras, we may take the total number of trains run over the road each way during one year as 350, or the total number $350 \times 2 = 700$, and for every extra mile these trains are run the increased cost to the road will be $\$0.50 \times 700 = \$350$; or one mile of increase of distance equals $350 and one foot equals $0.066 for one daily train each way for one year. This $350 is the yearly interest on the sum of money that can be economically spent per daily train to save this increase of distance of one mile or one foot. Taking the rate of interest at 6 per cent., $350 would be the yearly interest on $5,833.33; this, then, is the amount per daily train that could be spent economically over and above the original cost of construction to shorten the road one mile, and $0.066 is the annual interest on $1.10, which is the amount that could be spent economically over and above the original cost of construction to save one foot of distance.

When we say that this amount of money can be economically spent to save this distance, we take into account simply the operating expenses of the road. Of course, in actual practice, the ability of the road to raise this necessary money and the interest which it would have to pay on it during the time of construction would enter largely into the question; but as this is something which has to do solely with the financial stability of the railroad company and the state of the money market at the time the road is being built, it is not a question which enters in any way into our present calculation.

Putting these statements in tabular form, we have the following, the average or normal cost per train-mile being taken, as above, at $1.

I. Cost per Year per Daily Train of Additional Distance, Grade, or Curvature.

Unit.	Value per year per daily train.	Amount, capitalized at 6 per cent.
1 mile distance.....	$350.00	$5,833.33
1 ft. distance.....	0.066	1.10
1 degree curvature....	0.39	6.50
1 ft. rise and fall.....	2.33	38.33

II. Equivalent Distances, Grades and Curves in Terms of the Operating Expenses.

Items.	Distance.	Curvature.	Rise and fall.
1 mile.....	5,280 ft.	900 degrees.	150 ft.
1 degree curvature...	5.86 "	1 "	.166 "
1 ft. rise and fall.....	35.2 "	6 "	1 "

The operating expenses are calculated per year per daily train.

The following formula is the most simple method of using the above data, in finding the virtual length of a line:

$$V = e + \frac{g}{150} + \frac{c}{900}$$

e = Actual length of line in miles.
V = Virtual length in miles.
g = Rise and fall in feet.
C = Sum of all the central angles.

Then to find the actual amount that can economically be spent on the line with the longest virtual length to make it equal to the other line we have

$$\text{Amount} = \frac{(V - V')\ 35000\ t}{N}$$

where V = Virtual length of first line.
V' = Virtual length of second line.
$350 = cost per year per daily train.
N = Rate of interest.
t = Number daily trains.

The foregoing results apply to only such changes in length, curves, and grades as would produce a virtual difference in length of from 0 to about 2 miles in 100. For such changes as would produce a difference of from 2 to 10 miles in 100, about 10 or 12 per cent. should be added, and the relative disadvantages of any additions in length, curves and grades increases as the proportional amount of the addition increases, until soon a point is reached where the increase in the operating expenses due to this additional virtual length is directly as the increased length.

CHAPTER XXVI.

COMPENSATION FOR CURVATURE ON GRADES.

If, on a grade composed of curves and tangents, a uniform rate of grade is preserved, the effect upon the movement of trains is the same as if the curves had been removed and tangents of the same length, but an increased rate of grade, substituted for them: Thus, in Plate XLVIII, fig. 4, let $A\ B$ be a uniform grade having the alignment as shown on $A\ C$. Then the Virtual Grade, or the one which affects the movement of trains, is not the straight line $A\ B$, but the broken line $A\ b\ c\ d\ e\ f\ g$, the alignment of which is supposed to be a tangent.

That is, whenever a curve occurs upon a grade, the amount of resistance due to the grade is increased by the amount of resistance due to the curve, and in order to preserve a uniformity in the amount of motive power required, or the resistance to be overcome, the rate of grade should be lowered a certain amount on the curves.

What this amount should be we will now consider. We have found that, in terms of the resistance to be overcome, 600 degrees of curvature equal 25 ft. of rise and fall, or 1 degree of curvature equals 0.041 ft. of rise and fall.

Therefore, theoretically, the rate of grade should be reduced 0.041 per cent. per degree of the curves upon it, or, in other words, the rate of grade on curves should be reduced every station of 100 ft. by 0.041 times the degree of curvature, the amount being in feet.

There are, however, several questions upon the consideration of which it is found necessary to reduce the amount of compensation for curvature.

The amount of resistance opposed to the movement of a train by a curve by means of which 600 degrees of curvature is made equal to 25 ft. of rise and fall, is not known to be exact, even for the speed we have assumed for the train. It is only approximately correct for that one speed and not correct for any other.

The resistance due to a curve is very much greater with a very slow train and much less with a faster one. So that, even if our supposition is true under the conditions we have assumed, and we compensate our curves by the coefficient 0.041, it would not give a uniform resistance at any other speed. From this fact we see that the amount of compensation may be changed slightly either way without materially affecting the result.

Between any two points that are fixed and are at different elevations there is a certain amount of unavoidable rise and fall on any railroad line connecting them, and also, usually, a certain amount of curvature. If, therefore, all of these curves which occur upon grades are fully compensated for—that is, the rate of grade reduced on the curves—there will be just this amount of rise and fall *more* to go into the tangents, thereby increasing the rate of grade on them.

Thus, in order to have a uniform Virtual Grade upon a line having a fixed amount of rise and fall, not only must the trains all run at a uniform speed, but the length and degree of each curve must be known and the length of each tangent.

Then from these data a new coefficient of compensation must be calculated for each grade.

In order to obviate these complexities, and arrive at what shall be practically a uniform Virtual Grade, the compensation for Curvature on Grades may be taken generally at 0.03 per cent. per degree of curvature.

(TO BE CONTINUED.)

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page 257.*)

CHAPTER V.

THE FRAMES.

The frame of the hammer being subjected to great fatigue, especially when it rests directly on the bed-plate, it is important to give it such a form and section as may be best adapted to the work which it is to do and the weight which it is to support.

The best form is that which, for an equal weight, possesses the greatest moment of inertia and gives, in consequence, the maximum resistance. The form which best fulfills this end and which best resists the strains of torsion and bending is the hollow circular column; but in very large hammers the question of putting together the different parts makes a hollow rectangular form favorable, on account of the ease of fitting. Such a form has been adopted at Creusot and in the Steel Works of the Marine for their 80-ton hammers.

These frames have been made in three parts, solidly fastened together by means of bolts and wrought-iron hoops turned and put on hot, in order that should one of the parts break it will be easy to replace it at comparatively small expense and in a short time.

Where the frames are of cast iron we should avoid having parts in bearing together of too great thickness, for it often happens that these parts become detached under the action of shocks.

We should also take pains to have the thickness of section as uniform as possible, especially where the frames are hollow, so that injurious effects from reaction may be reduced to a minimum.

As a general rule, the frame—that is, the supporting frame or legs—should be divided in two parts below, in order to give as much space as possible for handling the forging, and to give room enough to set the anvil, and also at the same time to afford as wide a base as can be given.

We will now pass in review the different forms used for these frames, giving at the same time the names of the

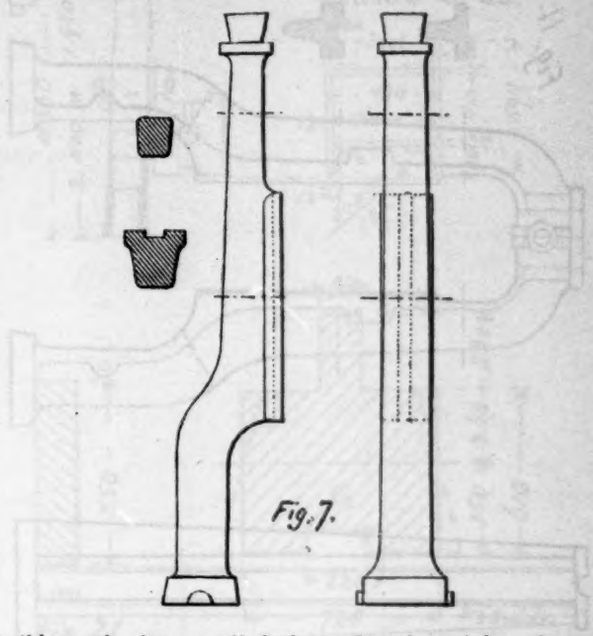


Fig. 7.

builders who have applied them. Sketches of these forms are given as follows:

Fig. 7. Creusot; l'Horme; Besseges; hammers from 1 to 4 tons.*

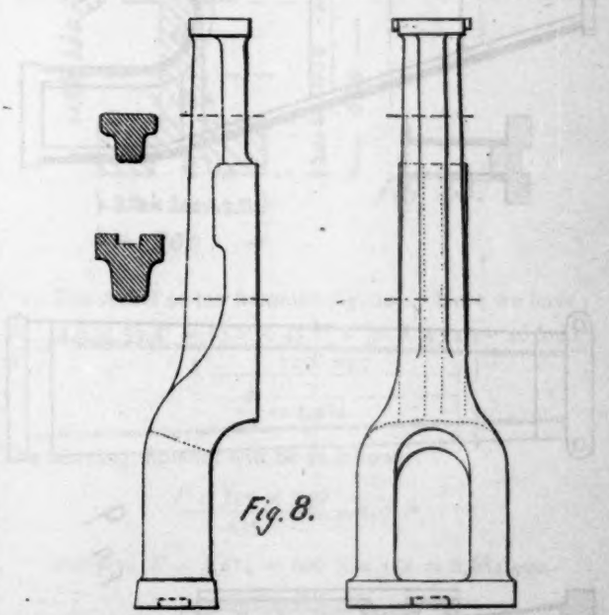


Fig. 8.

Fig. 8. Creusot; l'Horme; hammers from 2 to 20 tons; also Marrel Brothers, from 2 to 50 tons.

Fig. 9. L'Horme; hammers from 2 to 20 tons.

Fig. 10. Thwaites Brothers; hammers from 2 to 20 tons.

Fig. 11. Brunon; hammers from 1 to 5 tons.

Fig. 12. Nasmyth & Wilson; the Woolwich 35-ton hammer.

* Throughout these articles the metric measures and weights are used. They can readily be transferred, the reader remembering, of course, that 1 meter = 39⅜ in., and 1 kilogramme = 2,204 lbs. The metric ton is 1,000 kilogrammes, or 2,204 lbs.

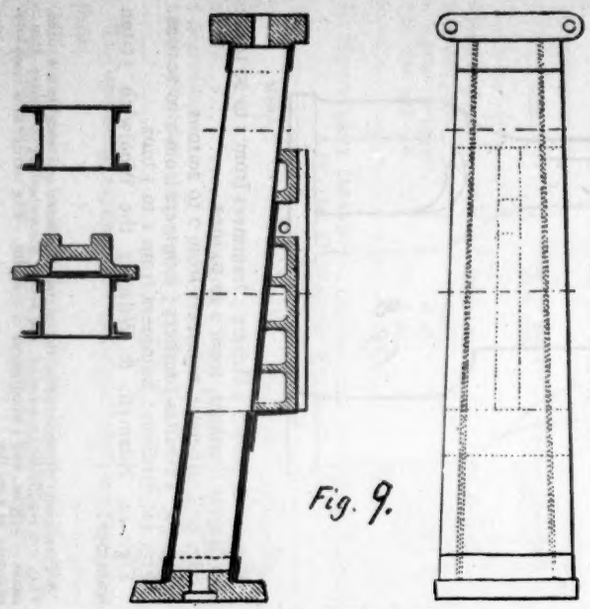


Fig. 9.

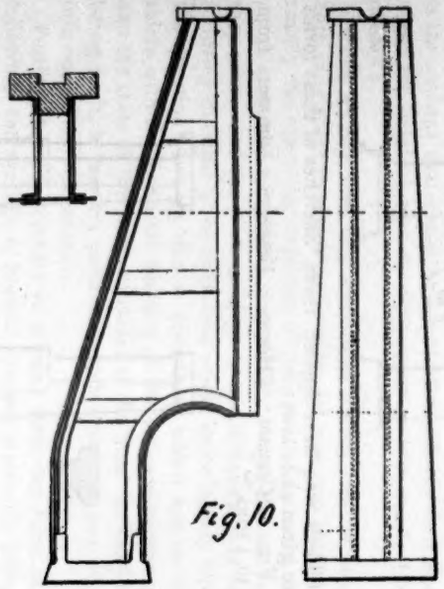


Fig. 10.

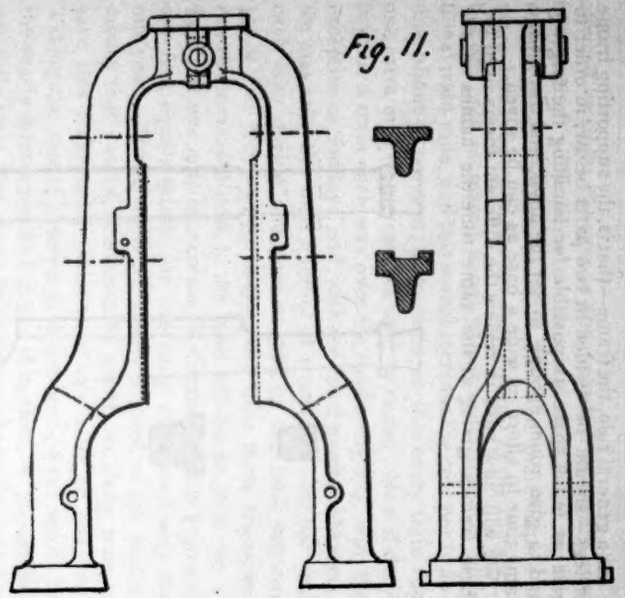


Fig. 11.

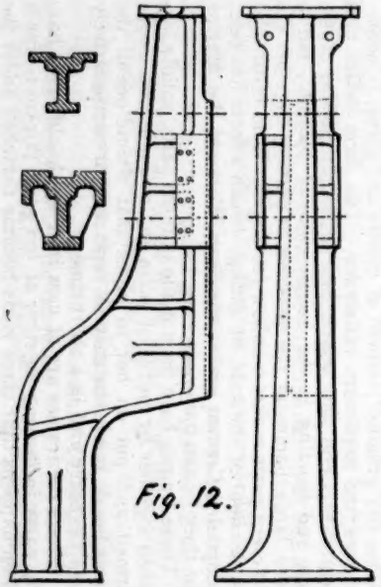


Fig. 12.

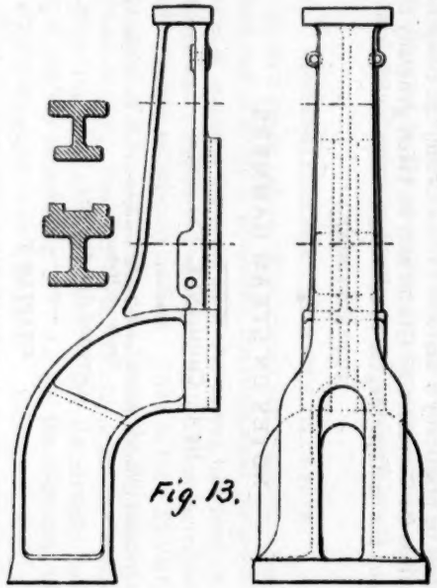


Fig. 13.

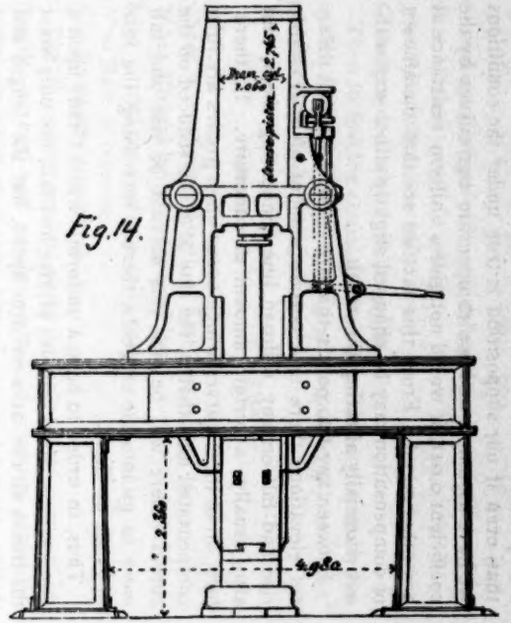


Fig. 14.

Fig. 13. Creusot Works; hammers from 4 to 20 tons.
Fig. 14. Thwaites Brothers; hammers from 5 to 15 tons.
Fig. 15. Thwaites Brothers; light hammers from 5 to 10 tons.
Fig. 16. Thwaites Brothers; heavy hammers from 5 to 20 tons.
Fig. 17. L'Horme; a later pattern for hammers from 5 to 20 tons.
Fig. 18. Thwaites Brothers; pattern used for the 35-ton hammer for Sir William Armstrong at Elswick.
Fig. 19. Pattern used for the 80-ton hammer in the Steel Works of the Marine and the 100-ton hammer of Marrel Brothers at Creusot.

Of several of these forms and sections of frame, especially of those in figs. 12–17, inclusive, we will speak again hereafter, when describing the details of the hammers.

M. Brunon has built a type of hammer (fig. 11) in which the two legs of the frame are united above in such a way as to form a circular recess or socket to receive the steam-chest. This plan has the advantage of dispensing with the upper frame or table, but has so much rigidity that it is necessary to make the section of the legs much heavier than in ordinary cases.

The type shown in fig. 14, which was designed by Thwaites, is in very common use in England.

The frames of the 80-ton hammer of the Steel Works of the Marine are strengthened or re-enforced at a certain height by heavy plates of wrought iron, which add to the solidity and insure the stiffness of the whole.

In the frames of the 100-ton hammer at Creusot there have been added, in addition to these braces below, two others above the slides of smaller dimensions than those below.

The legs or upright portion of the frame are joined to the upper frame or table in several ways.

1. By means of a conical lug which enters, but with considerable play, into the upper frame, which is fixed to the latter by wedges of wood compressed into the openings by means of iron keys. The object of this system is to take up as much as possible the shocks transmitted to the legs, and in consequence to prevent their breakage.

2. The second system consists of the use of bolts and of hoops put on hot, which secure a complete connection of the parts; this is especially used in the case of independent bed-plates, because then the shocks of which we have heretofore spoken are very much diminished and the chances of breakage are diminished; an example of this is shown in fig. 8.

We cannot close the description of this part of the hammer without speaking of those hammers with wooden pillars or frames, which are now gradually disappearing, having given place to metallic frames.

This type of hammer was studied out in 1857 for M. Arbel by M. Chalas, who was then Engineer of the Firminy Steel Works. It was especially intended for the manufacture of wrought-iron wheels for locomotives in the work-shops which M. Arbel had just established at Rive-de-Gier. It was necessary in this case to have a wide opening between the legs and much elasticity, the masses to be forged being so large and the blows required so heavy that the cast-iron frames—the only kind then used—did not present sufficient security for this work. M. Chalas conceived the happy idea of replacing them by wooden pillars. In this way great economy was secured, and the time necessary for the construction of the hammer was reduced one-half.

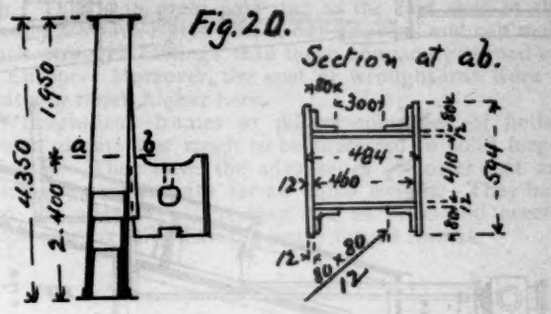
This type of hammer, then, fulfilled all the conditions required for this class of work: solidity, elasticity, and especially cheapness—a matter not to be despised in founding a new industry.

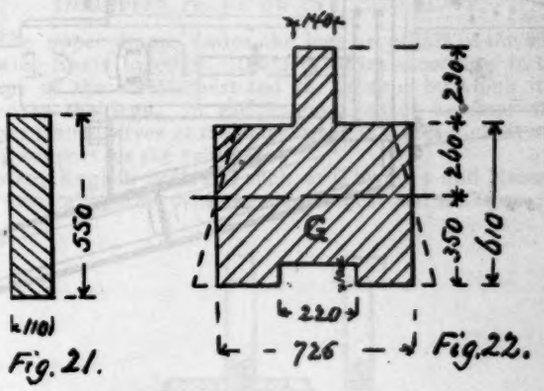
Hammers of this type have been constructed from 5 to 30 tons; they have rendered excellent service for a number of years, and the necessity of replacing them is still far from being felt.

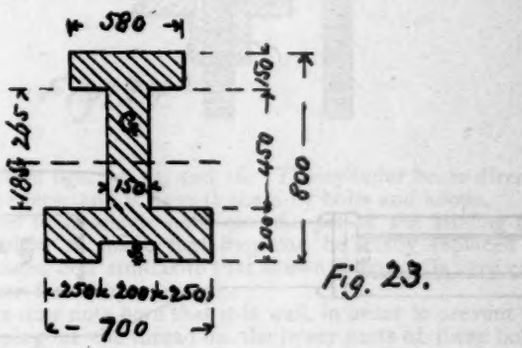
CHAPTER VI.

CALCULATIONS FOR THE FRAMES.

The required strength for the frames or uprights can be calculated, if we assume that they rest at their extremities on two points and take the force transmitted by the hammer itself at the end of its fall—that is, at the moment when it strikes the forging. We will here apply this method to four different types of hammers.







1. The Arbel 40-ton hammer (fig. 20). Here we have:

$$\frac{I}{n} = \frac{4.8 \times 59.4^3 + 13.6 \times 45.8^3 + 30 \times 43.4^3 - 46 \times 41^3}{12 \times 29.7},$$

$$\frac{I}{n} = 4.474.$$

The bending moment will be as follows:

$$\frac{P \times 195 \times 240}{435} = 107\,P,$$

$$107\,P = R \times 4.474 = 600 \times 4.474 = 2{,}684{,}400,$$

$$P = \frac{2{,}684{,}400}{107} = 25{,}090.$$

The ratio between this load P and the weight of the working parts is, then:

$$\frac{25{,}090}{40{,}000} = 0.62725.$$

As there are two pillars, one on each side, this ratio becomes $0.62725 \times 2 = 1.2545$—that is, the two uprights together should be able to support in this place, without experiencing any appreciable bending, a load of $1.2545 \times 40{,}000 = 50{,}180$ kilogrammes.

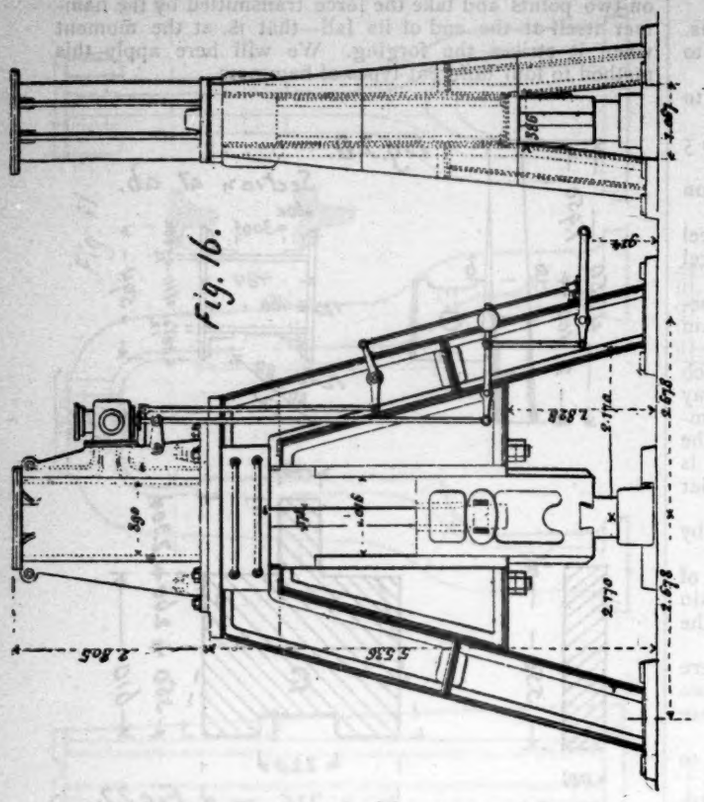


Fig. 16.

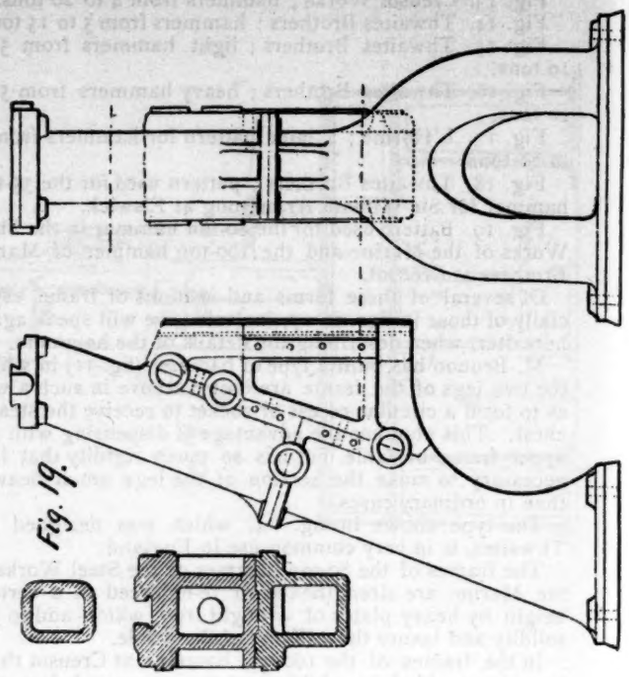


Fig. 19.

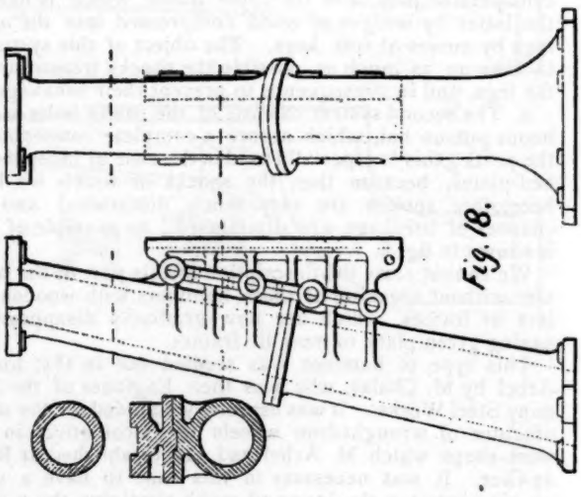


Fig. 18.

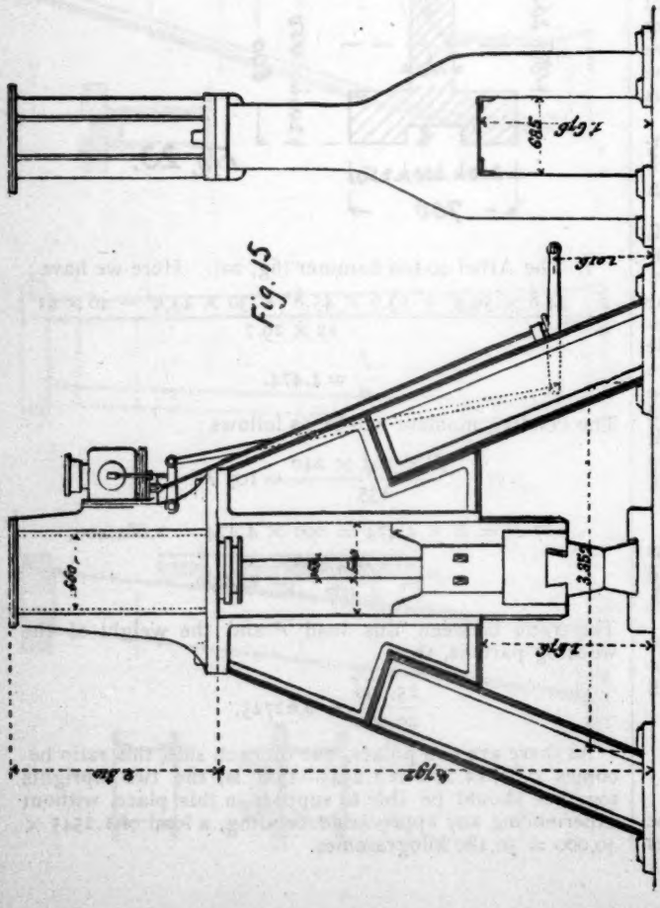


Fig. 15

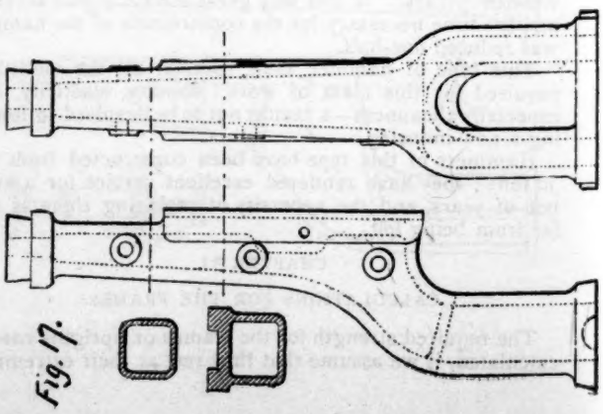


Fig. 17.

2. The Bietrix 15-ton hammer (fig. 21). Here we have:

$$\frac{I}{n} = \frac{11 \times 55^3}{12 \times 27.5} = 5,546.$$

The bending moment is as follows:

$$\frac{P \times 247 \times 210}{457} = 113\,P,$$

$$113\,P = R \times 5,546 = 600 \times 5,546 = 3,267,600,$$

$$P = \frac{3,267,600}{113} = 28,916.$$

The ratio between this load and the weight of the working parts will then be:

$$\frac{28,916}{15,000} = 1.9.$$

For the two pillars of the frame the ratio will then be 3.8.

3. The Creusot 20-ton hammer (fig. 22). Here we have:

$$\frac{I}{n} = \frac{58.5 \times 26^3 + 14 \times 49^3 + 50.5 \times 35^3 + 22 \times 25^3}{3 \times 49} = 44,600.$$

The bending moment is as follows:

$$\frac{P \times 320 \times 280}{600} = 150\,P,$$

$$150\,P = R \times 44,600 = 300 \times 44,600 = 13,380,000,$$

$$P = \frac{13,380,000}{150} = 89,200.$$

The ratio is, therefore:

$$\frac{89,200}{20,000} = 4.46.$$

This ratio is for a single pillar.

4. L'Horme 10-ton hammer (fig. 23). Here we have:

$$\frac{I}{n} = \frac{58 \times 41.5^3 - 43 \times 26.5^3 + 70 \times 38.5^3 - 55 \times 18.5^3 - 20 \times 38.5^3 + 20 \times 30.5^3}{3 \times 41.5}$$

$$\frac{I}{n} = \frac{6,321,486}{124.5} = 50,775.$$

The bending moment is as follows:

$$\frac{P \times 340 \times 280}{620} = 153\,P.$$

$$153\,P = R \times 50,775 = 300 \times 50,775 = 15,232,500,$$

$$P = \frac{15,232,500}{153} = 99,558.$$

The ratio is, therefore:

$$\frac{99,558}{10,000} = 9.96.$$

This ratio also is for a single pillar; it is very high, and shows that the section of the frame is very strong in proportion to the power of the hammer.

These four examples show us that—the resistance being 6 kilogrammes for wrought iron and 3 kilogrammes for cast iron—the ratio between the load P and the weight of the working parts of the hammer should never be less than 1.25 for hammers with wrought-iron frames and 4.00 for those with cast-iron pillars. For small hammers—up to 3 tons—this ratio should be increased to a figure as high as 15.

We believe that the future tendency will be toward frames of wrought iron, composed of hollow rectangular columns built up of plates and angles, rather than toward cast-iron frames, in which breakages are common, especially when they rest directly on the bed-plate. Besides this, the cost of cast-iron frames is greater than that of the wrought-iron, if we take into account the great difference in weight and the lower resistance of the cast iron. Small hammers up to 2 or 3 tons alone should be built with cast-iron frames, on account of the lighter section, the simplicity of form, and the ease of construction, which is important in these lighter tools.

In the United States, however, the practice is still to use cast iron for the pillars, even for hammers of considerable size. This is in great part due to the fact that in this country we have better iron at our disposal, and can make much stronger castings than those commonly turned out in Europe. Moreover, the cost of wrought-iron work is relatively much higher here.

Wrought-iron frames or pillars composed of hollow riveted girders are much to be preferred to solid forged columns. They have the advantages of lower cost and much greater strength for an equal weight. They have also the advantage that they can be fitted and erected much more readily than the heavy forged frames.

CHAPTER VII.

THE UPPER FRAME OR CYLINDER-PLATE.

The upper frame unites the legs or pillars of the supporting frame together. Its form varies according to the shape of the steam-chest and the method by which it is fixed to the legs. In the 80-ton Creusot hammer this upper frame serves at the same time as a steam-chest and as a support for the cylinder.

Many English builders, such as Thwaites and Massey, do away altogether with the steam-chest and the frame, as

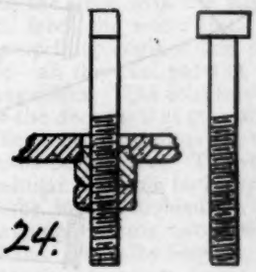


Fig. 24.

shown in figs. 14, 15, and 16. The cylinder bears directly on the legs, and is fixed to them by bolts and hoops.

The bolts which hold the flanges of the stuffing-box should be so made that they can be easily replaced; a T-headed bolt similar to that shown in fig. 24 is very convenient for this purpose.

We may note here that it is well, in order to prevent the stripping of the thread on the lower parts of these bolts, to make the holes in the flange of the stuffing-box through which the bolts pass large enough to permit the base of the nut to enter (as shown in fig. 24). These nuts can then be screwed up tight without any risk of injuring the thread, which is not the case in ordinary bolts, which are often injured by the unequal tightening of the nuts.

The stuffing-box is made in two parts, and is bored out in such a way as to permit the lower end of the piston-rod to pass through it freely.

The upper frame should have a section sufficiently large to resist the shocks which are transmitted to it. It must support, through the steam-chest, the total pressure exercised upon the piston.

In order to limit the stroke of the hammer and to prevent the shocks which might be caused by the carelessness or want of skill of the hammersmith, there are placed below the frame and on the face of the lugs on the upper part of the hammer two blocks of oak, which by their elasticity may absorb a part of the shocks transmitted, and often prevent the breakage of the stuffing-box and sometimes of the frame. This arrangement is much better than one which is often employed, and of which we have before spoken, which is to force two round pins of oak into the holes left in the lugs of the hammer, as the portion which is above at the moment of the stroke is the least sound; moreover, the section of the pins which can be forced into these holes is generally small, so that they are rapidly crushed in service.

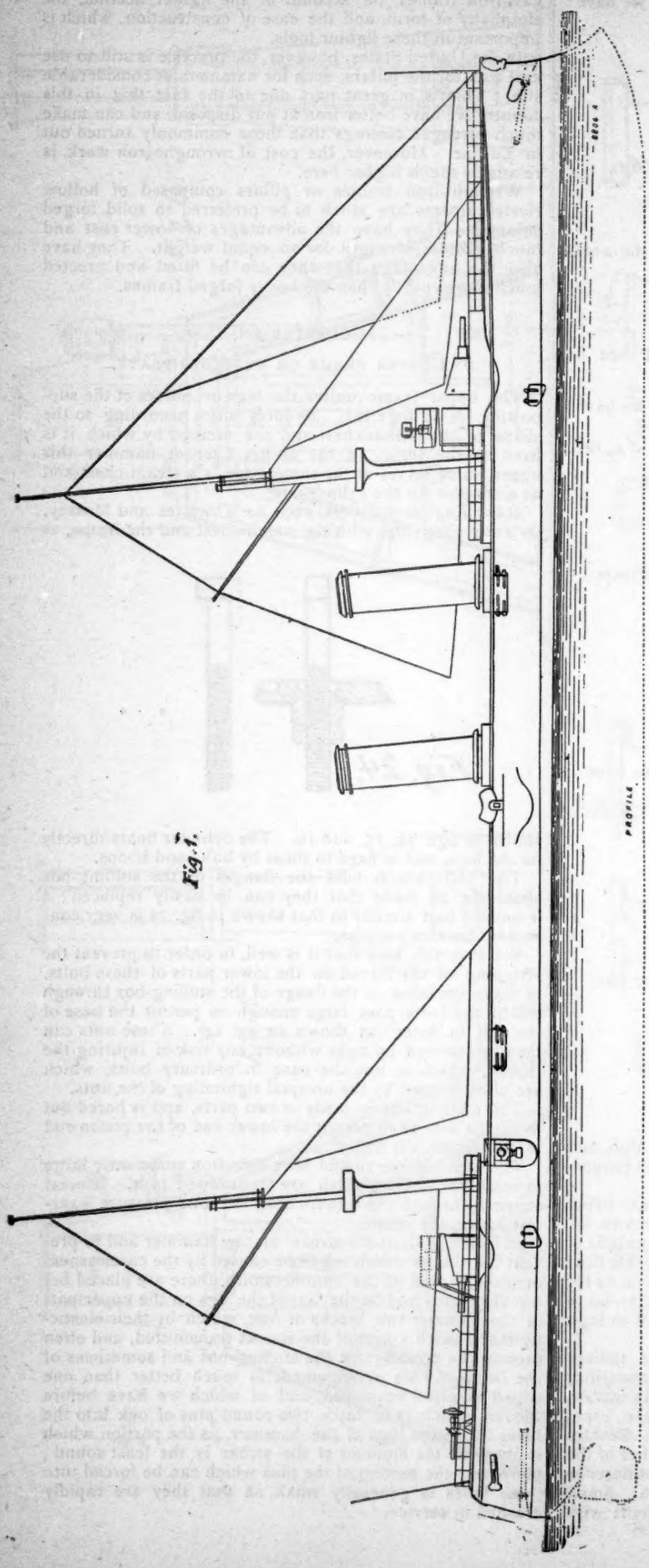


Fig. 1.

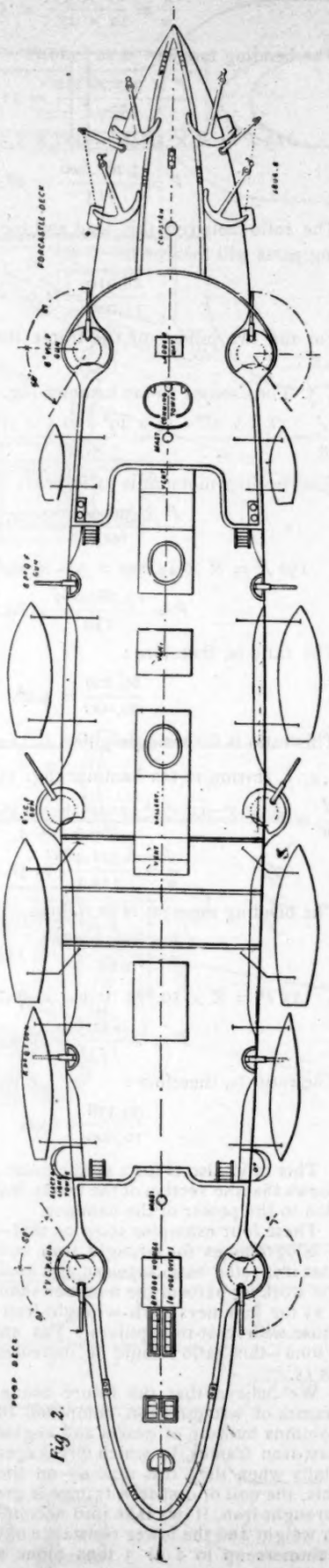


Fig. 2.

FAST CRUISER "MAGICIENNE," FOR THE BRITISH NAVY.

Built by the Fairfield Shipbuilding and Engineering Co., Glasgow, Scotland.

CHAPTER VIII.

THE CYLINDERS.

The cylinder does not require very particular mention, except to say that certain English and Belgian builders are accustomed to cast the cylinder and steam-chest in one piece.

The diameter of the cylinder should be calculated with reference to the minimum pressure of steam used in the shop, and the section of the piston-rod should be deducted, as the pressure of the steam is not, of course, exercised upon that part of the piston where the rod enters.

With very large hammers it is not unusual, after a heat which has been continued 30 minutes or over, to see the pressure fall from 5 to 3 kilos.; it is necessary that at such a time the diameter of the cylinder shall be so great that the hammer can be still worked at the reduced pressure.

Moreover, it is necessary to consider that it may be sometimes very useful, if we can increase the power of a hammer without making a new cylinder for it. This is a case which was recently presented at Creusot, where the weight of the large hammer was raised from 80 to 100 tons without changing the cylinder.

In this case, in order that the stroke should not be diminished, the hammer having been lengthened 1 meter, it was necessary to add between the pillars or legs and the upper frame two brackets 1 meter in length and to increase the diameter of the piston-rod from 360 to 420 millimeters.

In some very powerful hammers, which have usually a long stroke, the cylinder is made in two parts and the flanges are re-enforced by vertical ribs, which are tapered off gradually above the flange.

The face of the steam-chest on which the cylinder rests should be turned up slightly convex, in order that any water which may condense in the cylinder may run off at the outside, and may not pass into the stuffing-box, where it would probably corrode the metal and finally drip down upon the hammer.

(TO BE CONTINUED.)

The New English Fast Cruisers.

(From the London *Engineering*.)

THE most important vessels included in the programme of the British Admiralty for 1887–1888, were the five protective cruisers now building at Chatham and Portsmouth and on the Clyde, which include many new features in design and construction, and are a further development of a type of war ship, which, although not yet tried in actual warfare, is looked upon favorably by some naval constructors as a valuable auxiliary to the much more powerful and fully equipped ironclad. The five vessels are named *Medea*, *Medusa*, *Melpomene*, *Magicienne* and *Marathon*. The first two are building at Chatham, the *Melpomene* at Portsmouth, and the two last-named in the shipbuilding yard of the Fairfield Shipbuilding & Engineering Company at Govan, Glasgow.

The vessels are similar in dimensions and in their internal arrangements, but the constructive material and engines are different. The *Medea* and *Medusa* are being built entirely of steel, and their displacement will be 2,800 tons. Their engines are placed vertically, with inverted cylinders. In the case of the other three ships, the steel hulls are sheathed with wood and copper to enable them to remain afloat for long periods without having their bottoms fouled and their speed consequently reduced. This sheathing, of course, increases the displacement to within a few tons of 3,000 tons, and their speed may consequently be reduced by about ¼ knot to about 19¾ knots. Even in view of this slight loss of speed and the additional first cost which such an arrangement involves, the change of plan is acceptable, as it will give the cruisers an additional advantage over ordinary vessels, rendering them able to lie in coaling or other stations for a long period, and to be afterward available for a speedy voyage of action without the necessity of entering a dock in which to have the hull cleaned. With the exceptions indicated the five cruisers are alike.

Of the vessels, the *Marathon* is the furthest advanced, and was the first to be launched from the Fairfield yard, the launch of the *Magicienne* taking place later. Like the other ships of the same type, the *Marathon* is 265 ft. long, 41 ft. beam, and about 24 ft. deep, and the displacement will be between 2,950 and 3,000 tons. She was first built of steel in the usual manner and afterwards sheathed with two thicknesses of teak, making a total thickness of 6 in. The inside layer was attached to the steel hull by iron bolts, and the outside one by bolts of gun-metal. The bottom of the ship is further covered with sheets of copper nailed to the teak. The ram, stem, stern, and rudder-posts, and the brackets for supporting the twin screws by which the ship is propelled, are all cast in solid bronze, these castings together weighing for each ship about 45 tons. The form is similar to those generally used in the construction of Government vessels, the stern-casting being, of course, the more intricate. The whole structure is built and strengthened in such a way as to offer the maximum resistance to artillery.

For protection the vessel depends principally on a 2-in. steel deck extending from stem to stern. This deck resembles the back of a turtle, having a declivity at bow and stern and along the sides of the vessel. The top level of this deck—in the center of the ship—is practically level with the water line, and the declination all round makes the connection of the deck with the side of the ship at a point about 5 ft. from the water line. Under this deck are placed the propelling engines and the machinery for working the ship—all the vital parts of the mechanism—as well as the magazines. The coal bunkers are arranged above and below the deck in that part of the vessel where the engines, boilers, etc., are situated, so that additional protection may thus be secured. The vessel has a double bottom on the cellular principle for carrying water ballast. The interior of the hull is divided by bulkheads into 10 main water-tight compartments, two of which are occupied by engines, and two others by boilers. These four have no doorways between the spaces, but in some of the other bulkheads there have been fitted doors workable either at the door or from the top deck. In addition, these main compartments are subdivided especially above the protective deck, there being in all close on 270 water-tight spaces.

The machinery for the *Magicienne* and *Marathon*—the vessels building at Fairfield—has been constructed by Messrs. R. & W. Hawthorn, Leslie & Co., Limited, St. Peter's Works, Newcastle-on-Tyne. The engines for each of the cruisers are of the twin-screw horizontal surface-condensing type, each engine being placed in a separate water-tight compartment. The diameters of the cylinders are: High-pressure, 34½ in.; intermediate, 51 in., and low-pressure, 76½ in., the stroke of piston being 36 in. The engines are designed to run at 150 revolutions per minute, and the horse power to be indicated is 9,000. The total condensing surface is 11,850 square feet. The air pumps are driven from the pistons of the main engines. Separate feed engines, both main and auxiliary, are provided for feeding the boilers. There are also separate bilge and fan engines, feed-heaters, distillers of the latest double-distilling type, and separate surface-condenser with its air and circulating pump adapted for condensing all the steam from the auxiliary engines, dynamos for supplying the electricity to light the ship, air compressors, capstans, windlasses, etc. Steam is supplied to the main and all auxiliary engines in each ship from four double-ended cylindrical boilers, two in each of the compartments set apart for them. These boilers have in all 24 corrugated furnaces, with a grate surface of 456 square feet, and a heating surface of 14,070 square feet. They are constructed to work to a pressure of 155 lbs. per square inch. There are four stokeholds, which are arranged for working under forced draft on the "closed stokehold system" now universal in the Navy. The air is supplied to the furnaces when under forced draft by eight double-sided fans driven direct by high-speed engines. The machinery throughout is as light as it possibly can be consistently with due strength to withstand the strains which come

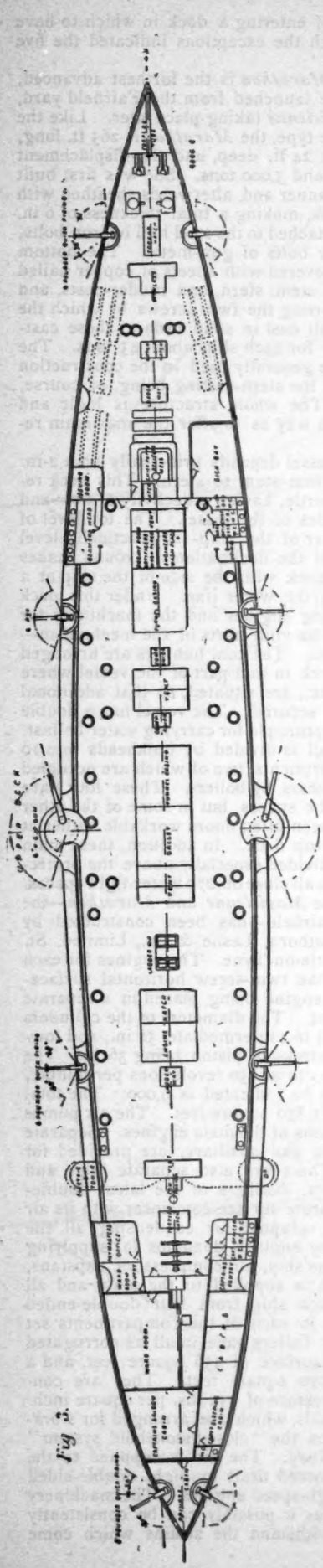


Fig. 3.

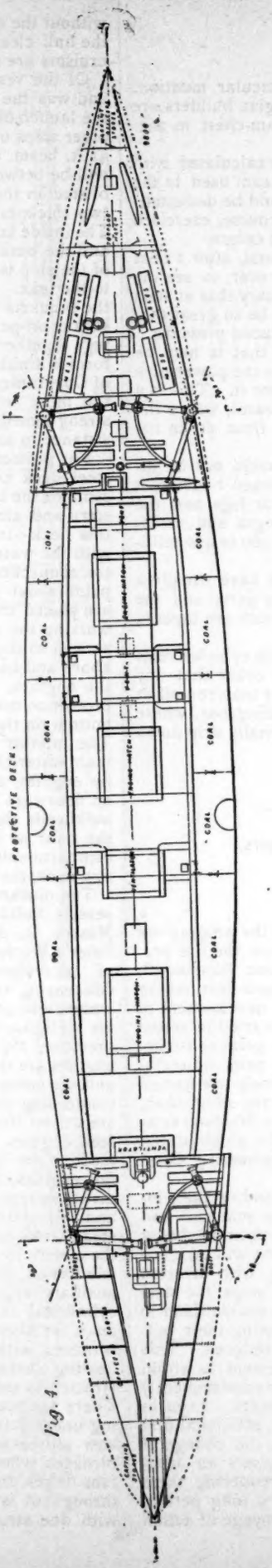


Fig. 4.

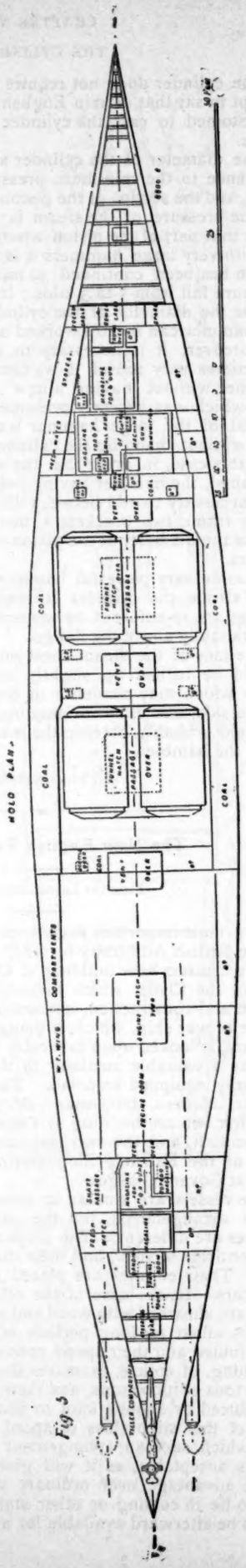


Fig. 5.

FAST CRUISER "MAGICIENNE," FOR THE BRITISH NAVY.

Built by the Fairfield Shipbuilding and Engineering Co., Glasgow, Scotland.

upon it when under forced draft and full speed. The shafting is entirely of steel, and is hollow; all rods are of the best mild steel, and the bed-plates, piston, piston valves, cylinder covers, and most of the valve gear are of cast steel. The stern tubes and propellers are of gun-metal. The framework of the rudder is of solid bronze, sheathed with thick gun-metal plates, and filled in solid with pitch pine. Particular care has been taken to provide against the steering gear being incapacitated. The rudder, which is on the balance principle now adopted in many war ships, can be worked by hand or steam gear placed under the protective deck, or from the bridge or pilot tower.

The armament of the ship consists of six 6-in. (5-ton) breechloading rifle guns, on central-pivot Vavasseur mountings, two placed forward, two aft, and one each on starboard and port side amidships; ten 6-pounder quick-firing guns, three light guns under 15 cwt., and several machine guns. Six torpedo tubes are to be fitted on board, all under cover, one forward, another aft, and two on each broadside.

Accommodation has been provided for a crew of about 300 men all told. The officers are accommodated under the poop aft, and the "tars" forward. There are the usual cabins, ward, gun and mess-rooms.

The external appearance of the vessel will be smart. She has two funnels and two masts. These will only have fore-and-aft steadying sails, the vessels being solely dependent upon their steam power and twin screws to drive them along at the high speed of 19¾ or 20 knots. The military tops are to be dispensed with in these vessels. This many will regard as a step in the right direction, as the "crow's nest" has been looked upon often as the most likely spot at which the enemy would aim.

The estimated cost of the hull of each of these vessels, as given in the Navy Estimates, is £64,790; of the machinery at £50,824, while the total cost, including gun mountings, torpedo gear, and stores, is calculated to be £136,752.

The vessels were designed under the supervision of Mr. W. H. White, Director of Naval Construction. They were commenced in August last year, and those building at Fairfield are expected to be completed in November next, so that the time occupied in their construction will be between 15 and 16 months. This, however, must not be regarded as the "record" of the Fairfield Company in speedy shipbuilding. One of the principals in the yard is reported to have said, when interviewed by a representative of a London shipping journal: "With our resources in this yard we could turn out a war vessel in three months from date of order if necessary, and there are other builders that could do nearly the same."

UNITED STATES NAVAL PROGRESS.

We give below several notes in relation to naval matters of interest which have occurred during the past month.

NEW SHIPS.

The appropriation bill reported to the House of Representatives by the Naval Committee authorizes the expenditure of $6,000,000 for the increase of the Navy, $4,000,000 being for construction of ships and $2,000,000 for armament. The bill provides for the construction of four ships; two unarmored cruisers of about 3,000 tons displacement, each to have a guaranteed speed of 19 knots; one unarmored cruiser of 5,300 tons, with a guaranteed speed of 20 knots, and one armored ship of about 7,500 tons displacement, with no guarantee of speed, but planned to make not less than 17 knots. One of the four must be built in a navy yard, and all may be built in such yards if the President is satisfied that none of the bids made by contractors is reasonable.

The acts of March 3, 1885, August 3, 1886, and March 3, 1887, authorized the construction of ships to cost in the aggregate a trifle less than $20,000,000. The amount thus far appropriated for these ships is $8,315,000. This is exclusive of about $7,000,000 appropriated for guns and armor in 1886 and 1887, of which about $4,000,000 will be required to pay the contracts made with the Bethlehem Iron Works a year ago, leaving $3,000,000 to the credit of the Secretary.

Leaving out the double-turreted monitors and the four cruisers, there has been spent on the ships ordered in the past three years $2,403,935, and the balance on hand for them is $3,453,848. The double-turreted monitor *Miantonomoh* will be finished in four months. The large cruiser *Baltimore* will be launched this month and finished in six months. The *Vesuvius* will be ready for delivery on September 1. The double-turreted monitor *Puritan* has had her dock trial and has been accepted, but her armor has not been put on. The double-turreted monitor *Amphitrite* is ready for her steam trial, which will occur soon. The machinery for the double-turreted monitor *Monadnock* is in process of construction at Mare Island Navy Yard, from plans prepared in the Navy Department. Three years ago some of the forgings for the 6-in. guns for the Navy had to be imported from England, and all the forgings for the larger guns had to be brought from abroad. Now the forgings for 8-in. guns are made here, and the contract of last year with the Bethlehem Iron Works will make the United States independent of England, even in the case of forgings for the largest guns projected and for the heaviest steel shafting.

The stern-post of the cruiser *San Francisco*, which is to be built by the Union Iron Works in San Francisco, has been successfully cast, and the keel is now being laid.

The Herreshoff Manufacturing Company at Bristol, R. I., has begun work on the new torpedo-boat. This boat will be 138 ft. long, and will have twin screws, with engines capable of working up to 1,800 H.P. The contract speed is 25 knots an hour, and the builders hope to attain 28 knots. The boat will be entirely of steel.

The bids for steel to be used in building the armored cruiser *Maine*, at the New York Navy Yard, were recently opened at the Navy Department, and were as follows:

For steel plates:
- Carnegie, Phipps & Co., Pittsburgh, $89,779. (Accepted.)
- Chester Rolling Mill, Chester, Pa., $114,240.
- Linden Steel Company, Pittsburgh, $120,422.

For steel shapes:
- Carnegie, Phipps & Co., Pittsburgh, $35,986. (Accepted.)

For steel rivets:
- Carnegie, Phipps & Co., Pittsburgh, $9,737. (Accepted.)
- Oliver Brothers, Pittsburgh, $10,584.

For steel castings:
- Pittsburgh Steel Casting Company, Pittsburgh, Pa., $50,176.
- Midvale Steel Company, Nicetown, Pa., $56,448.
- Standard Steel Casting Company, Thurlow, Pa., 18 cents per pound.

NEW GUNS.

Some recent firings at Sandy Hook with the Army 12-in. breech-loading steel mortar for long range tests have given highly satisfactory results. With a charge of 80 lbs. powder and 630 lbs. shell a range of six miles and 135 yards was obtained.

The two 8-in. breech-loading steel guns built by the West Point Foundry for the *Chicago* have been completed and shipped to the proving grounds at Annapolis for test.

The 10-in. steel breech-loading rifled gun designed for the iron-clad *Miantonomoh*, and the first steel gun of this caliber completed by the Navy, has been finally adjusted upon its hydraulic carriage at the Annapolis Proving Grounds, and fired to test the working of the carriage and breech mechanism. These worked easily and accurately, and the gun is now in a condition to carry on experiments for determining the proper grade of powder with which to conduct the statutory tests.

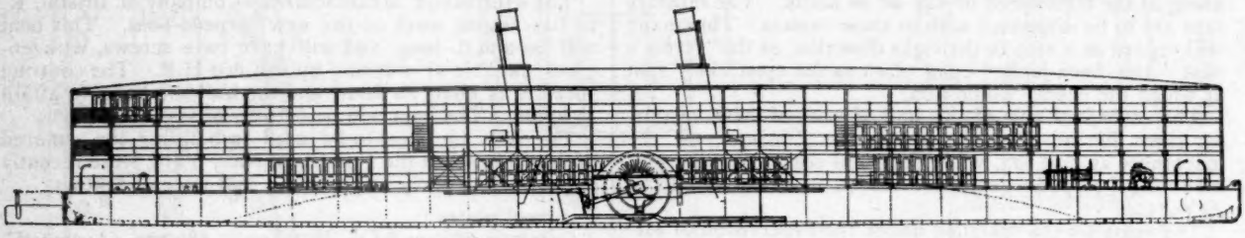
Work at the Naval Ordnance Yard, Washington, is very brisk just now. Work on the breech plug to replace the one destroyed some weeks ago, belonging to the 10-in. gun, is making satisfactory progress, and, if no further accidents happen, the gun for which it is being made will be completed and ready for the proving butts at Annapolis within a month or two. On the new ordnance building in

course of construction considerable progress has been made in the erection of outer walls and piers for supports, but it is not likely that the building will be ready for occupancy before some time next spring. An immense amount of work is in progress on gun carriages and fittings for the batteries of the new cruisers now on the stocks.

The new 53-ton gun recently completed at the South Boston Iron Works is shortly to be tested at Sandy Hook under Government supervision. The gun is of the French type, and is a 12-in., breech-loading, cast-iron rifle, hooped and tubed with steel. It is 30 ft. long. The standard of the trial is 500 rounds, using an 800-lbs. projectile and a charge of 265 lbs. of powder. At the South Boston Works two built-up steel rifles are also in partial construction. These have 8-in. bores, and are entirely of steel. Two 8-in. pneumatic gun carriages for rifle use are also in progress, as well as four 10-in. carriages of a smaller type for use on the monitor *Terror*.

A River Steamer of English Design.

IN the Exhibition at Glasgow there is a large collection of drawings and models shown by the leading shipbuilding firms in Great Britain. This collection is especially large, as might be expected, from the firms whose yards are located on the Clyde. As an example of the methods adopted by British shipbuilders to overcome the difficulties of river navigation, we take from the London *Engineer* the accompanying description of a steamer designed and built by Denny & Brothers, of Dumbarton, Scotland, for service on the Irrawaddy River, in Burmah, where at certain seasons the navigation is much impeded by low water and bars in the river, very similar to the obstructions found in many of the western and southern rivers.



STEAMBOAT "THOOREAH," FOR THE IRRAWADDY RIVER, BURMAH.

Built by Denny & Brothers, Dumbarton, Scotland.

The paddle steamer *Thooreah* is represented by a full model, which is shown in our illustration. This is a very interesting exhibit, from the fact that the depth of the hull is so small when compared with the enormous superstructure erected thereon. She is of steel, her dimensions being 260 ft., by 34 ft., by 9 ft. deep amidships, tapering to 7 ft. 6 in. at the extremities, and she is owned by the Irrawaddy Flotilla Company. Above the main deck, and supported on light tubular stanchions, there are two other decks, and above these again is a galvanized iron roof. She has been employed successfully both as a tug and a passenger steamer. Her spacious decks give enormous accommodation for native passengers, who travel about on the rivers in great numbers. The method adopted on the Irrawaddy for towing barges is peculiar to Indian and Burmese rivers. The barges, instead of being towed astern, are lashed one on each side of the tug, and it is a peculiar sight to see a flotilla consisting of a steamer and her two barges moving up or down the river, the whole mass being nearly as broad as it is long. The problems involved in the construction of a steamer of such great length and small depth of hull proper are of much difficulty, and are solved only by making the high superstructures co-operate with the body of the vessel as one huge yet light girder. Longitudinal strength is, too, largely obtained by means of double fore-and-aft bulkheads, extending nearly the entire length of the steamer. Owing to the great difficulties encountered in the navigation of the Burmese rivers, especially in the dry seasons, the draft of these vessels is sometimes limited to as little as 3½ ft., and although carrying so much top hamper, they are able to travel at a speed of 12½ knots. Messrs. Denny seem to have overcome all the difficulties involved in Eastern river navigation, and turn out some dozens of these steamers and barges every year.

Testing Armor-Plates.

(From the London *Times*, May 21.)

THE experiments with armor-plates were resumed on board the *Nettle*, at Portsmouth, on Saturday, in the presence of Admiral Hopkins, Superintendent of the Dockyard, Captain Douglas, R.A., of the Ordnance Committee, and Captain Domville, of the *Excellent*, who conducted the firing. The previous experiments were made with compound, or steel-faced, armor, such as is now exclusively used for the protection of British war ships, the competing systems of manufacture being what are known as the Wilson and Ellis patents. A 10-in. plate by Messrs. Cammell & Co., Sheffield, exhibited most extraordinary endurance and impenetrability. Though attacked by the new 6-in. breechloader with chilled and solid steel projectiles, it completely resisted perforation at 30 ft., and was little the worse, so far as the integrity of the defense was concerned, after having sustained the blows of five rounds in quick succession. On Saturday the experiments entered upon their second phase, the object being to determine the comparative resisting value of solid steel plates. Several of the great naval powers have adopted steel armor, and even in England, notwithstanding the experience derived from experiments conducted at Spezia, Amager, and elsewhere, naval officers have brought pressure to bear upon the Government with a view of securing the introduction of homogeneous steel plates.

Before venturing, however, to abandon a system of defense which, from the combination of toughness and hardness in the composite material, had withstood the preliminary ordeals very satisfactorily, the Admiralty determined to ascertain the respective merits of the two descriptions of armor by a series of tests under identical conditions. The competition is limited to English firms, and from the behavior of the plate which was subjected to experiment on Saturday there is every probability that our native manufacturers will be able to more than hold their own against those of either France or Germany. The difficulty which attends steel armor is that if made too hard it stars and cracks through under the blows of guns of comparatively light natures, and that when subjected to continuous punishment the plates become so disintegrated that the fragments are only held in position by means of the bolts; and that when, on the contrary, the metal is of too mild a nature, they permit the projectiles to penetrate without breaking them up or materially altering their form.

The plate tested on Saturday was manufactured by Messrs. Cammell & Co., and was forged under their new hydraulic press, which is capable of exerting a pressure of 5,000 tons. In its way it was quite as remarkable as the compound plate which broke up all the shot, both steel and chilled, directed against it. It measured 8 ft. by 6 ft.,

and was of a thickness of 10 in. The composition of the steel is a trade secret, but its flexibility was such that it passed through the ordeal under fire without splintering or falling in pieces like the Creusot plates. Five shots were discharged against it from the 6-in. gun at a 30 ft. range. Two were chilled Palliser projectiles, while the remainder were Hartzel solid forged steel shot. The charge was 42 lbs., the muzzle velocity 1,920 ft. per second, and the muzzle energy 2,556 foot-tons. The chilled shot were entirely broken up, but the indents in the plate were deeper than in the case of compound armor. The steel projectiles were pointed diagonally across the face of the plate from the bottom right corner to the top left corner, the difference in the inclination of arm having an important effect upon the ballistic value of the various rounds. The first shot fired at the normal penetrated the plate, the base being about 5 in. below the surface. The second shot, fired at an inclination of 8°, buried itself in the target with the exception of 2½ in.; while the third and last round, fired at a deviation of 16° from the normal, protruded about 7 in. from the face. None of these projectiles were broken up, but plugged themselves into the softer nature of the plate, where they remained firmly fixed.

The armor-plate itself at the end of the experiment, though cracked in places, retained its position on the backing, and was in a fair state of preservation. Though the shot discharged point-blank at the target penetrated the plate, none succeeded in getting through, but were arrested and held firmly in the grip of the metal. In actual war the possibility of a normal hit is so remote a contingency that it need scarcely be taken into consideration. It is as yet too soon to speak with any certainty as to the superiority of one system over the other; but it is evident that with steel as with compound armor the Sheffield firm has more than kept pace with the Continental manufacturers.

NOTES ON THE SEWERAGE OF CITIES.

(Translated from paper of M. Daniel E. Mayer, Engineer, in the *Annales des Ponts et Chaussées.*)

(*Continued from page* 259.)

IV.—GENERAL ARRANGEMENT OF A SYSTEM OF SEWERS.

In most cities there are old sewers which have been built on the lines of the greatest fall of the surface, in order to carry waste water to the river by the shortest route. Later, when the pollution of the river waters in their passage through the city has become intolerable, the idea has been conceived of building a collecting sewer along the bank of the river to gather water from the transverse sewers and to take it to some point below the city. This second step in the work of sanitation may be considered a definite one, leading the way to a very wide future, in cities like Munich, Vienna and Buda-Pesth, where the river passing through the city has, even in times of low water, a great volume or an extremely rapid current, and where there are no large collections of people below or near the city.

It may be noted here, however, that the municipal administrations of the three cities which we have just mentioned have taken care to make a place in their programme of sanitary work for the future use of the sewage for the irrigation of farm lands.

It happens more frequently, however, that the conditions cited above—a river having a great volume of water or a very rapid flow—are not fulfilled, and the purification of the sewage becomes a necessity.

In this case, however, the concentration of all the waste water upon some point in the valley below the city is not absolutely indispensable. This is the case in Berlin, which is situated on a level plain, and where an original solution of the problem, known as the radial system, was adopted, in which the sewers run from the center of the city to different points selected on the outskirts, and at each of these points there is established pumping machinery which distributes the water through a system of irrigating channels to farms in the neighborhood.

We do not, however, insist upon this system, which, though excellent for the peculiar location of Berlin, would not be applicable in an uneven country, nor to a smaller city. The purification of the sewage waters and their use for irrigation generally require motive power and complicated machinery, and there are very few cities whose importance justifies the establishment of more than one plant of this description.

We must then consider the plan of concentration of sewage at a single point as a normal programme, and the local conditions generally indicate that this point should be below the city. If the bulk of the population and of the buildings are upon a slope which descends with a well marked fall to the river bank, the main collecting sewer must be placed in the immediate vicinity of the river.

But if—a case which frequently happens—the city is divided into two parts, on one side a rapid slope followed by a nearly level valley, there will be an advantage in placing the main collecting sewer at the foot of the slope, in order to avoid the necessity of carrying all the water from that slope through the flat valley; and frequently the subsoil will be much more favorable for the construction of

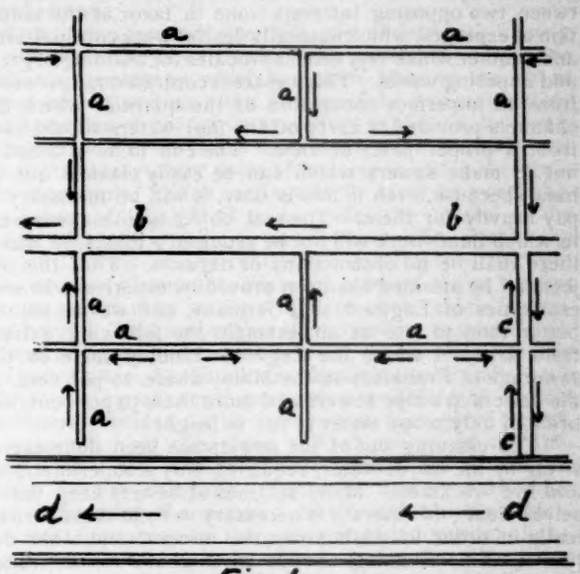


Fig. 1.

subterranean works at the foot of the hill than in the immediate vicinity of the river.

It is only necessary to place the collecting sewer so low that the districts on the banks of the river can discharge their foul waters into it. In order that the sewers of these low districts shall have sufficient fall it will generally be necessary to start them at a point very near the surface. This may be somewhat inconvenient for the purpose of drainage of low land, but, as we have already had occasion to remark, buildings placed too low—that is, on land naturally swampy, or which is subject to overflow—are from this fact burdened with natural drawbacks from which the community is not bound to relieve them, so that the consideration of providing for such cases should not be permitted to modify the general arrangement to any extent.

In order to fix and represent these ideas, we have shown in the accompanying sketch, marked fig. 1, the outline of the arrangement of a system of sewers. In this sketch *a a a a* are ordinary sewers; *b b b* the main or general collecting sewer; *c c* is a branch sewer, which can be used either as an ordinary sewer, or, on occasion, for the discharge of rain water directly into the river; *d d* is the river.

The sewers of the higher part of the city should be able to carry the great volume of rain water of which we have spoken heretofore. But if these sewers, or partial collectors, have a heavy fall, and serve only an area of which one of the dimensions—the width—can be chosen, they

can be arranged in such a way that comparatively small dimensions will be sufficient.

If the main sewer is so arranged that the overflow from very heavy rains can be diverted into the river by means of the auxiliary sewers, it will be necessary to make it only sufficiently large to carry off the surplus water from an average rain. However, in view of the comparatively light fall of the valley it will be generally necessary to make it a work of considerable dimensions.

Frequently the sewers between the river and the main collecting sewer will have a fall less than that of the sewers leading from the higher ground, but greater than that of the main sewer, and as they will not be charged with the overflow from unusual rains (which can be turned directly into the river), small dimensions will be sufficient for them, as for those in the upper districts.

We are now to consider the forms which are best to be given to these sewers, whether small or large, and the best method of dividing among them the fall or slope which is at our disposal.

V.—ARRANGEMENT AND PROFILE OF SEWERS.

We are often called upon in discussing the problem of sewers to treat it in such a way as to hold the balance between two opposing interests: one in favor of the reduction of expenses, which naturally desires works of small size, and another which very often advocates the building of great and imposing works. This apparent contradiction proceeds from an imperfect conception of the qualities which the channels provided to carry off the foul waters should have from a proper point of view. The end to be attained is not to make sewers which can be easily cleaned out by hand, because, even if this is easy, it will be necessary to pay heavily for them. The real object is to make sewers in which hand-work will not be required; that is, in which there shall be no obstructions or deposits. That this object can be attained has been proved by experience in several cities of England and Germany, and we cannot do better than to cite as an example the following extract from a report which the Engineer Lindley made on the sewerage of Frankfort-on-the-Main, where 20 per cent. of the sewers are pipe sewers and more than 50 per cent. are brick of only 0.093 meter (3 ft.) in height:

"The cleaning out of the sewers has been done exclusively by the use of water, requiring only a superintendent and five workmen. Many sections of sewers keep themselves clear; in others it is necessary to flush them periodically in order to wash away the mineral and other deposits. This cleaning service costs about 10,000 francs yearly for the 143 kilometers of the system."

It is not necessary to believe that these excellent results required a very great consumption of water, because, at the time when the lines quoted were written, the City of Frankfort had at its disposal a volume of water less than the 150 liters per inhabitant per day which we have heretofore noted as normal.

This example is not a solitary one, and it is found from experience that in a city where the land is not unusually flat, and where the consumption of water per inhabitant per day approaches the figure of 150 liters, a well arranged system of sewers can keep itself clean. It is only necessary, in order to secure this end, that the precautions, of which we have before spoken, should be taken to prevent the introduction of solid bodies into the sewers.

As, in spite of these precautions, the water sometimes holds solid matter in suspension, it will be necessary to arrange the sewers so that the swiftness of the current will not fall below a certain rate.

The English Engineer, Baldwin Latham, in an excellent paper on this question, fixes, from a large number of facts and experiments, upon 0.062 meter (2 ft.) as a speed below which we should not fall if we wish to avoid deposits in the sewers.

M. Humblot estimates that a speed of 0.090 meter (3 ft.) is insufficient to carry off sand, but that mud and slime will be put in motion under a current of 0.030 meter (1 ft.)

It is, moreover, evident that this object of avoiding deposits will be better attained if the average current of the whole system is greater than that named.

These considerations will lead us, then, to determine the dimensions of the sewers with a view of obtaining the maximum speed of current possible; and, as this maximum for a given duty corresponds to a minimum section of sewer, it will be seen that the best interests of the work are not opposed to but are absolutely identical with economy in the first cost of the system.

This disposed of, we have to study the practical formula for the flow of water:

$$\frac{M}{X} I = b u^2$$

In this formula M is the liquid section, or section of the current of water, in meters; X is the perimeter of the current; I is the fall per kilometer; u is the minimum swiftness of the flow per second; b is an empirical coefficient.

We may call Q the quantity of water (in cubic meters) which flows or passes per second.

If the sewer is semicircular the maximum value of u will correspond with the case when the diameter, D, of the passage, for a given value of Q, is so chosen that the semicircle may be filled; hence we have:

$$U = 0.70 \left(\frac{Q I^2}{b^2}\right)^{\frac{1}{5}}$$

$$D = 2 \left(\frac{b Q^2}{I}\right)^{\frac{1}{5}}$$

If the passage is rectangular, the maximum value of u will correspond to the case where the width, l, of the passage, for a given value of Q, is so chosen that the height of the water shall be equal to $\frac{1}{2} l$; hence we have:

$$U = 0.66 \left(\frac{Q I^2}{b}\right)^{\frac{1}{5}}$$

$$l = 1.74 \left(\frac{b Q^2}{I}\right)^{\frac{1}{5}}$$

There is another form of conduit, hardly applicable practically to city sewers, but theoretically interesting; it is that of a right-angled triangle. This form is the only one in which $\frac{u^5}{Q I^2}$, as given in the practical formula, does not depend on Q; in fact, whatever may be the value of Q, we find:

$$\frac{u^5}{Q I^2} = \frac{1}{8 b}$$

The relation here is the same as that which obtains with the rectangular conduit, when we assume the width of that conduit to be so determined from the value of Q as to give u its maximum value.

There are several remarks to be made on these formulæ.

In the first place, we see that the old Latin and French proverbs, "Too much is better than too little," and, "He who can do the greater can do the less," are not applicable to sewer conduits. There is a size of conduit which corresponds, for each duty, to a maximum swiftness of flow; but if the conduits are made too large it is at the expense of the swiftness and velocity of the flow.

This has been proved in Paris, where, for reasons already explained, it has been necessary to make very large passages and to use a radius of 0.50 meter in streets where the ordinary discharge is small. The thread of water spreading itself over too large a surface looses its swiftness and produces troublesome deposits. An easy way to overcome this is found by making a sewer within a sewer—that is to say, a small conduit within the large passage-way. The author, while in the municipal service at Paris, designed, with the Engineer-in-Chief, M. Durand-Claye, a sewer of this kind, and this type is now being generally applied to all the secondary passages.

The formulæ which give the diameter or the width of the conduit contain b, with the exponent $\frac{1}{5}$. For an error, e, in the value of b the relative error in calculating the value of l or D will be only $\frac{1}{5} e$.

According to the experiments of M. Bazin, the value of b depends on $\frac{M}{X}$, and, where the walls of the conduit are moderately smooth, is as follows:

$\left(\frac{l}{4}\text{ or }\frac{D}{4}\right) = \frac{M}{X}$	$= 0.500$	$b = 0.2166$
" "	$= 0.250$	" $= 0.2432$
" "	$= 0.150$	" $= 0.2964$
" "	$= 0.100$	" $= 0.3233$
" "	$= 0.075$	" $= 0.3667$
" "	$= 0.050$	" $= 0.4567$

The coefficient 0.33, uniformly assumed by Belgrand, thus represents an average value too high for very large sewers and too low for very small ones, but sufficiently exact in the great majority of cases, so far as concerns the determination of l or D.

If we substitute this value ($b = 0.33$) in the preceding formulæ, they become:

$$\text{Semicircular conduit} \begin{cases} U = 1.094\ (Q I^2)^{\frac{1}{3}} \\ D = 1.600\ \left(\frac{Q^2}{I}\right)^{\frac{1}{5}} \end{cases}$$

$$\text{Rectangular conduit} \begin{cases} U = 1.021\ (Q I^2)^{\frac{1}{3}} \\ l = 1.410\ \left(\frac{Q^2}{I}\right)^{\frac{1}{5}} \end{cases}$$

In determining the size of sewers we should see that the value of $Q I^2$ (Q being the ordinary duty) should be as great as possible, and that sewers of the same class should preserve a certain uniformity. It is also true that, for the general or main collecting sewer, we should not seek to distribute equally over its length the entire fall from the starting point to the final discharge, but to give more fall to the upper portions of it, because they receive less water.

In order that the condition that u should be greater than 0.062 should be well filled, it is sufficient that $Q I^2$ should be greater than 0.100, and this requirement is generally satisfied unless the local conditions are extremely unfavorable.

There is one consideration which may modify the very simple arrangement shown in the sketch above, and this is the necessity of keeping up the fall of the water throughout a system of sewers. It may, in fact, happen that even in the higher part of the system a street running parallel to the direction of the valley may have a very slight fall and may receive very little water. In this case it might be useful, in order to give a proper value to $Q I^2$, to cause the water coming from a higher sewer to pass through this street in the direction of the greatest fall of the land, and, in consequence, to break the direct flow of the waters of the latter sewer.

This change in the direction of the current of a sewer will be accompanied by a loss of speed, but the inconvenience arising from this will be much diminished if we take care to bring one sewer into the other at a proper angle or by a circular curve.

(TO BE CONTINUED.)

Electric Lighting of Cars in England.

(From the London *Electrical Review*.)

IT would appear that the applicability of the electric light to the illumination of our railway trains is now in a fair way to be thoroughly tested. Trains on the London, Brighton & South Coast line have, for some time past, been lighted by the electric current; and, now for some months also, have trains on the Metropolitan Great Northern system been similarly illuminated. But all these trains are trains *en bloc*—*i.e.*, trains which run to and fro on their journey without being broken up. The lighting of these trains has been accomplished by means of a dynamo and accumulators placed in the guard's van. The dynamo is driven from the wheels of the van, and an electrical or mechanical governor completes or breaks the circuit between the dynamo and the accumulators according to the speed of the train. Provision is also made for the regulation of the current according to the direction in which the train is traveling, so that there may be no reversals in charging the batteries.

To purely local trains this system is possibly applicable, but inasmuch as it involves enveloping any portion of the train which may be disconnected from that portion in which the accumulators and dynamo are placed in darkness, should such a mishap at night-time occur, it cannot be regarded as wholly reliable. Still, the system has been useful, and has done good work in that it has, so far, served to prove not only the excellence of the light for the purpose, but afforded considerable experience in the application of accumulators, life of lamps, etc. In fact, what has been done has been the accomplishment of a certain stage on the road. We have learned that secondary batteries may be used for the purpose; that the motion of the train and the usage to which the batteries have necessarily to be subjected have not proved their unfitness for the work. We have also learned that the vibration of the train does not materially interfere with the life of the carbon filament—that if the lamp is properly fixed and judiciously worked its life may be regarded as equal to that of a lamp employed for illuminating our rooms. These are all stages on the road toward the final application to railway demands.

What these demands are will, we understand, shortly be placed to the test by one of the principal lines. The Midland, a company which has often stood in the van of improvement, and as often advanced the accommodation and interests of the great traveling public, is, we hear, about to fit up two trains upon such a basis as will embrace practically every point of interest to which the question may apply. Each carriage is to carry its own lighting power. The light is to be under the control of the guard, who is to be able to turn it on or off. Should any part of the train or any vehicle become detached the light is to become illuminant, while the storage of the current is to be sufficient to insure a light in each vehicle for several hours. This means that the secondary batteries will, instead of being, as in previous trials, placed all together in the guard's van, be distributed throughout the train, each vehicle having an equal proportion, sufficient to sustain the lamps provided for its illumination for a given period. In accomplishing this there will, of course, be no difficulty; but it will involve greater expenditure on the part of the railway company. There is, however, no other way of effecting the required result, and which no doubt is a most desirable one, the provision of independent lighting power for each vehicle. The batteries thus distributed will be charged by a dynamo placed in the guard's van, driven from the wheels of the vehicle. This will involve the employment of somewhat heavy cables throughout the train, for it is probable that very low currents will be employed in order to reduce the number of cells, although there is very much to be said in the other direction. Here will probably transpire one of the main difficulties to be contended with—viz., a good and reliable coupling capable of carrying the amount of current required—possibly some 60 ampères.

Broadly these are the principles which will, it is understood, be attempted, and which, if attended with success, will at once, no doubt, establish the applicability of the electric light to railway locomotion—a result which will be received by all railway travelers with delight, for nothing can be much more miserable on a long journey than the wretched lights with which our railway carriages are at present, for the main part, illuminated.

It is understood that the experiment will extend over several months, and that the entire working to which a railway train may be subjected will be carried out. This will comprise "slip" coaches as well as the ordinary making and breaking up of the train at points on the journey; certain of the vehicles being detached to accomplish the remainder of the allotted journey at certain points, apart from that portion of the train in which the dynamo is placed. The trial will thus be of the most exhaustive character.

We understand that negotiations are also pending for lighting a portion of the stock of a northern company, but upon what principle has not transpired. The fact is, however, apparent, that railway companies are seeking to im-

prove the lighting of their trains, and are looking to the electric light to aid them in their efforts. We believe they will have no cause to regret their resolve. We are quite of opinion that with proper management large economies will attend the introduction of this form of light for railway train lighting. If successful in its application two important and highly satisfactory results will be accomplished: the companies will provide for the public an agreeable and popular form of light, and, at the same time, effect a considerable saving on their existing cost for lighting.

NATIONAL RAILROAD REPORTS.

ON June 1 the Interstate Commerce Commission issued an important circular addressed to "all carriers engaged in interstate commerce." This circular is as follows:

The Interstate Commerce Commission desires to call your attention to the subject of the Annual Reports, which are provided for by Section 20 of the Act to Regulate Commerce, as follows:

SEC. 20. That the Commission is hereby authorized to require annual reports from all common carriers subject to the provisions of this act, to fix the time and prescribe the manner in which such reports shall be made, and to require from such carriers specific answers to all questions upon which the Commission may need information. Such annual reports shall show in detail the amount of capital stock issued, the amounts paid therefor, and the manner of payment for the same; the dividends paid, the surplus fund, if any, and the number of stockholders; the funded and floating debts and the interest paid thereon; the cost and value of the carrier's property, franchises, and equipment; the number of employés and the salaries paid each class; the amounts expended for improvements each year, how expended, and the character of such improvements; the earnings and receipts from each branch of business and from all sources; the operating and other expenses: the balances of profit and loss; and a complete exhibit of the financial operations of the carrier each year, including an annual balance-sheet. Such reports shall also contain such information in relation to rates or regulations concerning fares or freights, or agreements, arrangements, or contracts with other common carriers, as the Commission may require; and the said Commission may, within its discretion, for the purpose of enabling it the better to carry out the purposes of this act, prescribe (if in the opinion of the Commission it is practicable to prescribe such uniformity and methods of keeping accounts) a period of time within which all common carriers subject to the provisions of this act shall have, as near as may be, a uniform system of accounts, and the manner in which such accounts shall be kept.

Said Act applies to all common carriers engaged in such transportation of passengers or property as is described in its first section. Very many railroads, which are located wholly within one State, are, nevertheless, very largely engaged in interstate commerce. In fact, under the present methods of conducting joint traffic, nearly every road, however short its line, unites in making through rates, under which it issues and receives tickets or bills of lading, in connection with roads in other States, upon which passengers and freight are transported across State boundaries; the revenues of every such road are derived, to a greater or less extent, from the traffic which is regulated by the provisions of the Interstate Commerce Law.

The information which this law authorizes the Commission to require is very general in its nature and scope. It embraces "a complete exhibit of the financial operations" of the carriers each year, as well as all the details which are enumerated in the section quoted above.

It is apparent that it was the purpose of Congress to inaugurate an annual collection of statistics, which should faithfully present the entire transactions of every railroad in the United States for the preceding year; and that the information so obtained should be authoritative and trustworthy.

Such returns, when arranged upon a uniform system and presented under official sanction, cannot fail to be of great interest and value to all carriers, as well as to Congress and the public.

As to many of the matters enumerated, the value will be greatly lessened if the statistics are incomplete. No attempt has heretofore been made to provide for a general collection of railroad facts and figures, except through unofficial methods and by the Census Bureau. For obvious reasons these methods have not given satisfactory results, in comparison with the annual statistics which are obtained in other countries. A new plan has been established, under the supervision of official authority, in the expectation that a permanent and uniform system of reports, both as to date of compilation and form of statement, may soon prevail throughout the land.

In preparing the blank return, which is now in press and about to be issued, every effort has been made to reduce it to a simple, intelligible, and practicable form. If the efforts of this Commission shall be seconded by the Railroad Companies and by the various State Railroad Commissioners, it is entirely feasible to speedily bring all railroad accounts throughout the United States upon a uniform basis, and to present them annually to the country and to the world in a manner worthy of the importance of the subject.

Up to this time the suggestions and requests of the Commission have been most satisfactorily met by both the State Commissions and the carriers. A very free interchange of views has been had with the accounting officers, in the first place before the preparation of an experimental form, and afterward in its revision and correction. The blank about to be issued is believed to be the closest approach to a universally satisfactory system which has yet been made in this country. It is also confidently believed that there is no information asked which the carriers cannot readily furnish and will not cheerfully give, and it is hoped that every detail of inquiry has a permanent value.

The Commission, therefore, without ruling definitely at the present time upon the question of what railroad companies may or may not be required by the act to file the returns in question, will furnish blanks to *every* railroad company in the United States, whatever its situation or relative importance, in the belief that every carrier will cheerfully and promptly contribute its share toward the attainment of a complete and trustworthy annual exhibit of the entire railroad system of our country.

ACCIDENTS ON BRITISH RAILROADS.

THE report of the Board of Trade on Railroad Accidents for the year 1887 has recently been issued. The summary showing the total number of accidents to persons on British railroads from all causes during the year is as follows:

Accidents to trains, rolling-stock, permanent way, etc., caused the death of 733 persons, and injury to 647—viz.:

	1887.		1886.	
	Killed.	Injured.	Killed.	Injured.
Passengers and others	25	538	8	615
Servants of companies	8	109	4	81
Total	33	647	12	696

During the year 1887 there were reported 31 collisions between passenger trains or parts of passenger trains, by which 25 passengers were killed and 244 passengers and 14 servants were injured; 42 collisions between passenger trains and goods or mineral trains, etc., by which 1 servant was killed and 187 passengers and 47 servants were injured; 16 collisions between goods trains or parts of goods trains, by which 2 servants were killed, 6 cattle dealers and drovers and 24 servants were injured; two cases of trains coming in contact with projections from other trains traveling on parallel lines by which 6 passengers were injured; 49 cases of passenger trains or parts of passenger trains leaving the rails, by which 1 servant was killed and 20 passengers and 10 servants were injured; nine cases of goods trains or parts of goods trains, engines, etc., leaving the rails, by which 3 servants were killed and 1 was injured; two cases of trains traveling in the wrong direction through points, by which 1 servant was injured; 23 cases of trains running into stations or sidings at too high speed, by which 1 servant was killed and 52 passengers and 5 servants were injured; 116 cases of trains running

over cattle (during the year 25 horses, 3 ponies, 55 beasts and cows, 108 sheep, 7 donkeys, 1 goat and 2 pigs were run over and killed) or other obstructions on the line, by which 3 servants were injured; 4 failures of engine machinery, by which 2 servants were injured; 1 failure of brake apparatus, by which 15 passengers were injured; 3 failures of couplings, by which 1 passenger and 1 servant were injured; 5 slips in cuttings or embankments, by which 1 passenger and 1 servant were injured; and two other accidents, by which 6 passengers were injured.

The following cases were also reported, but they involved no personal injury: 47 cases of trains running through gates at level crossings; 1 case of the bursting of the dome of an engine; 767 failures of tires; 1 failure of a wheel; 281 failures of axles; 1 failure of a chain used in working an incline; 1 failure of a bridge; 1 failure of a tunnel; 244 broken rails; 8 cases of flooding of the permanent way; 8 fires in trains; and 9 fires at stations or involving injury to bridges or viaducts.

Of the 767 tires which failed, 15 were engine-tires, 14 were tender-tires, 8 were carriage-tires, 21 were van-tires, and 709 were wagon-tires; of the wagons 515 belonged to owners other than the railway companies; 651 tires were made of iron and 116 of steel; 21 of the tires were fastened to their wheels by Gibson's patent method, and 2 by Beattie's, none of which left their wheels when they failed; 30 by Mansell's, one of which left its wheel when it failed; 35 tires broke at rivet-holes, 8 at the weld, 125 in the solid, and 599 split longitudinally or bulged.

Of the 281 axles which failed, 161 were engine axles, 145 crank or driving, and 16 leading or trailing; 20 were tender axles, 3 were carriage axles, 94 were wagon axles, and 3 were salt-van axles; 53 wagons, including the salt-vans, belonged to owners other than the railway companies. Of the 145 crank or driving axles, 82 were made of iron and 63 of steel. The average mileage of 80 crank or driving axles made of iron was 216,412 miles, and of 63 crank or driving axles made of steel, 235,649 miles.

Of the 244 rails which broke, 96 were double-headed, 147 were single-headed, and 1 was of the bridge pattern; of the double-headed rails, 52 had been turned; 26 rails were made of iron and 218 of steel.

Of the 472 persons killed and 977 injured in this division, 96 of the killed and 759 of the injured were passengers. Of the latter, 19 were killed and 61 were injured by falling between carriages and platforms—viz., 8 killed and 36 injured when getting into, and 12 killed and 467 injured when alighting from trains; 37 were killed and 20 injured while passing over the line at stations; 72 were injured of the closing of the carriage doors; 2 were killed and 23 injured by falling out of carriages during the traveling of trains; and 24 killed and 60 injured from other causes. There were 63 persons killed and 35 injured while passing over railways at level crossings—viz., 29 killed and 28 injured at public level crossings, 21 killed and 7 injured at occupation crossings, and 13 killed at foot crossings. There were 203 persons killed and 114 injured when trespassing on the railways; and of other persons not specifically classed, but mostly private people having business on the companies' premises, 40 were killed and 69 injured.

During the year there were 414 servants of companies or contractors reported as having been killed and 1,966 injured, in addition to those suffering from train accidents. Of these 26 were killed and 232 injured while coupling or uncoupling vehicles; 4 were killed and 29 injured by coming in contact while riding on vehicles during shunting with other vehicles, etc., standing on adjacent lines; 16 were injured while passing over or standing under buffers during shunting; 20 were killed and 135 injured in getting on or off, or by falling off engines, wagons, etc., during shunting; 7 were killed and 123 injured while breaking, spragging, or chocking wheels; 14 were killed and 75 injured while attending to ground points, marshaling trains, etc.; 8 were killed and 187 injured while moving vehicles by capstans, turntables, props, etc., during shunting operations; 19 were killed and 76 injured by falling off engines, vans, etc., during the traveling of trains; 6 were killed and 148 injured while attending to or by failure of machinery, etc., of engines in steam; 99 were killed and 97 were injured while working on the permanent way, sidings, etc.; 3 were killed and 2 injured while attending to level-crossing gates; 93 were killed and 127 injured while walking, crossing, or standing on the line of duty; 9 were killed and 55 injured by being caught between trains and platforms, walls, etc.; 37 were killed and 36 injured while walking, etc., on the line on the way home or to work; and 7 were killed and 99 injured from various other causes.

Altogether, the number of persons killed and injured on railways in the United Kingdom in the course of public traffic, during the year ending December 31, 1887, as reported to the Board of Trade, was as follows:

	Killed.	Injured.
Passengers:		
From accidents to trains, rolling-stock, permanent way, etc.	25	538
By accidents from other causes	96	759
Servants of companies or contractors:		
From accidents to trains, rolling-stock, permanent way, etc	8	109
By accidents from other causes	414	1,966
Persons passing over railways at level crossings	63	35
Trespassers (including suicides)	273	114
Other persons not coming in above classification	40	69
Total	919	3 590

In addition to the above, the railway companies have reported to the Board of Trade, in pursuance of the Sixth Section of the Regulation of Railways Act, 1871, the following accidents which occurred upon their premises, but in which the movement of vehicles used exclusively upon railways was not concerned—namely: 3 passengers killed and 139 injured while ascending or descending steps at stations; 36 injured by being struck by barrows, falling over packages, etc., on station platforms; 48 injured by falling off platforms; and 2 killed and 71 injured from other causes. Of servants of companies or contractors, 3 killed and 979 injured while loading, unloading, or sheeting wagons; 2 killed and 292 injured while moving or carrying goods in warehouses, etc.; 3 killed and 162 injured while working at cranes or capstans; 2 killed and 363 injured by the falling of wagon-doors, lamps, bales of goods, etc.; 3 killed and 404 injured by falling off, or when getting on or off, stationary engines or vehicles; 7 killed and 292 injured by falling off platforms, ladders, scaffolds, etc.; 2 killed and 225 injured by stumbling while walking on the line or platforms; 190 injured while attending to stationary engines in sheds; 1 killed and 50 injured by being trampled on or kicked by horses; 8 killed and 490 injured while working on the line or the sidings; and 3 killed and 256 injured from various other causes. Of other persons, most of whom were transacting business on the companies' premises, 19 were killed and 160 injured, making a total in this class of accidents of 58 persons killed and 4,157 injured.

Thus the total number of personal accidents reported to the Board of Trade by the several railway companies during the year amounts to 977 persons killed and 7,747 injured.

The Distribution of Hydraulic Power in London.

(Abstract of paper read before the British Institution of Civil Engineers by E. B. Ellington.)

THE Author observed that water power is no new force, but that, as formerly understood, it was limited in its application to systems of mechanism suitable for the low pressures found in nature. The effects obtained by the use of high pressure were so different in degree from all previous experience that a new name was needed, and had been found in the term "hydraulic power." Bramah's genius produced the hydraulic press, and he clearly foresaw the future development and great capabilities of his system; but it was reserved for Lord Armstrong to work out and superintend the intricate details that had to be developed before the system could be made fully serviceable. The public supply of hydraulic power in London constitutes the latest development of this system. The hydraulic power is supplied through mains charged by pumping at a pressure of 700 lbs. per square inch. The first and largest pumping station has been erected on a site known as Falcon Wharf, about 600 ft. east of Blackfriars Bridge. The engine-house at present contains four

sets of pumping-engines, each set being capable of exerting 200 indicated H.P. The engines are vertical-compound, of a type comprising the advantages of a three-throw pump with direct connection between the pump-plungers and the steam-pistons. Each set of engines will deliver 240 gallons of water per minute into the accumulators, at 750 lbs. pressure per square inch, at a piston speed of 200 ft. per minute. This is the normal speed of working, but, when required, they can be worked at 250 ft. per minute, the maximum delivery being 300 gallons per minute. The condensing water is obtained from storage tanks over the engine-house, and is returned by circulating pumps to one or other of those tanks. The water delivered into the mains is maintained all the year round at temperatures of between 60° and 85° Fahr. The boilers are of the double-flued Lancashire type, and are made of steel. All are fitted with Vicars's mechanical stokers. At the back of the boilers is a Green economizer, consisting of 96 tubes. The economizer and the stoker gear and worm are driven by a Brotherhood three-cylinder hydraulic engine.

The reservoir of power consists of accumulators. The accumulators at the pumping station are two in number, each having a ram 20 in. in diameter and of 23-ft. stroke. The weight cases are of wrought iron, and are filled with iron slag. The total weight of the case and load on each ram is approximately 106 tons, corresponding to a pressure of 750 lbs. per square inch. The storage tanks form the roofs for the engine and boiler houses. The water for the power-supply is obtained from the River Thames, and is pumped into the tank over the engines. The water passes through the filtering apparatus by gravity into the filtered-water tank over the boiler-house, which is 7 ft. below the level of the unfiltered-water tank. The filters consist of cast-iron cylinders, and each contains a movable perforated piston and a perforated diaphragm, between which is introduced a quantity of broken sponge; the sponge is compressed by means of hydraulic pressure from the mains. The delivery of power-water from the Falcon Wharf pumping station is through four 6-in. mains. The most distant point of the mains from the accumulators is at the west end of Victoria Street, and is 5,320 yards, or just over 3 miles. To provide for all frictional loss in the pipes and valves, the accumulators have been loaded to 750 lbs., the stated pressure supplied being 700 lbs. per square inch. The total length of the mains at present laid is nearly 27 miles. The mains are laid in circuit, and there are stop valves at about every 400 yards, so that any such section of main can be isolated. The method employed for detecting leakage is based upon an automatic record of the number of gallons delivered into the mains, and in cases of abnormal increase during the night, if found to arise during the early hours of the morning, the mains are tested. The power-water used is invariably registered through meters on the exhaust pipes from the machines, and from the meters passed to the drains. There is a sliding scale of charges from 8*s*. ($2) to 2*s*. ($0.50) per 1,000 gallons at 700 lbs. pressure per square inch, designed to meet, as nearly as possible, the variable conditions and requirements of consumers. The more continuous the use, the lower the charges. The scale is intended chiefly for intermittently acting machinery, and experience has fully proved that these rates are sufficiently low to effect a large saving to the consumer in almost all cases, whether for a large or a small plant. The Author believes any idea of supplying power from a central source, at rates much below these, to be chimerical. The practical efficiency of the hydraulic system may be fixed at from 50 to 60 per cent. of the power developed at the central station. No other method of transmission would, to say the least, show a better result; and the general convenience and simplicity of the hydraulic system are such that its use would hardly be affected even if there were no direct economy in the cost of working.

In addition to the general supply of hydraulic power, in the city and adjoining districts, to the 650 machines at present worked, a new departure has been taken by the application of hydraulic power to an estate at Kensington Court, the name given to an area of about 7 acres, facing Kensington Gardens. Seventy houses and dwellings are to be built on this estate, of which 30 have been already erected. Each house is fitted with a hydraulic lift, taking the place of a back staircase, and the power-supply is provided on the estate expressly for working these lifts. The driven machinery is as of great importance to an economical and satisfactory result as the distributing plant, but this obvious fact is not always understood. General regulations have been prepared by the Author, defining the conditions to be observed by manufacturers in fitting up machinery for connection to the power mains. They are intended to secure safety and an efficient registration of the quantity of power used; but they leave the question of the economy and of the efficiency of the machines to be settled between the consumers and the makers. In London more lifts are working from the mains, and more power is used by them, than by any other description of machinery. The number of all classes at present at work is over 400. The principal types in use were fully described. In some cases there have been, by adopting the public supply, a saving in the cost of working of about 30 per cent., as compared with the steam-pumping plant previously in use. Lifts are now becoming so general, and the number of persons who use them is so great, that the author considered it necessary to urge the importance of securing the greatest possible safety in their construction by the general adoption of the simple ram. Suspended lifts depend on the sound condition of the ropes or chains from which the cages hung. As they become worn and unreliable after a short period, it is usual to add safety appliances to stop the fall of the cage in case of breakage of the suspending ropes, but they cannot be expected to act under all circumstances. As an indication of the important part which lifts occupy in a modern hotel, it may be mentioned that at the Hôtel Métropole there are, including the two passenger lifts and that for passengers' luggage, no less than 17 hydraulic lifts in use day and night, while the work done represents about 2,000 tons lifted 40 ft. in this time. The next largest use of the power is for working hydraulic cranes and hoists of various kinds along the river side and in the city warehouses.

It often happens that the pressure in the power mains is not sufficient for pressing purposes. The apparatus known as an intensifier is then used, by which any pressure required can be obtained. Hydraulic power is also used at Westminster Chambers, and elsewhere, for the purpose of pumping water from the chalk for domestic use. The pump is set going in the evening, and continued working till the tanks are full, or until it is stopped in the morning. For work of this kind, done exclusively at night, a discount is allowed from the usual rates. Mr. Greathead's injector hydrant, made at the Elswick Works, has been in use to a limited extent in London in connection with the power mains. A small jet of high-pressure water, injected into a larger jet from the water works mains, intensifies the pressure of the latter in the delivery hose, and also increases the quantity. By this means a jet of great power can be obtained at the top of the highest building without the intervention of fire-engines. This apparatus enables the hydraulic power-supply to act as a continuous fire-engine wherever the mains are laid, and is capable of rendering the greatest assistance in the extinction of fire; but there is an apathy on the subject of its use difficult to understand. In Hull, the corporation has had put down a number of these hydrants in High Street, where the hydraulic power mains are laid, and they have been used with great success at a fire in that street. The number of machines under contract to be supplied with power is sufficient, with a suitable reserve, to absorb the full capacity of the station at Falcon Wharf, and another station of about equal capacity is now in course of erection at Millbank Street, Westminster. The works have been carried out jointly by the Author and Mr. Corbet Woodall, Mr. G. Cochrane being Resident Engineer and Superintendent. The pumping-engines, accumulators, valves, etc., and a considerable portion of the consumers' machinery, have been constructed at the Hydraulic Engineering Works, Chester. Sir James Allport, who was the first to adopt hydraulic power for railroad work, has been associated with the enterprise from the commencement of its operations in 1882. His wide influence and extended experience have greatly assisted the commercial development of the undertaking.

Quadruple-Expansion Yacht Engines.

(From the London *Engineer*.)

THE accompanying illustrations show a new type of quadruple-expansion engine lately built by Fleming & Ferguson, of Paisley, Scotland. The illustrations are taken from the drawings of small engines of about 120 H.P., which are to be placed in a yacht being built for Mr. Sholto Douglas. We may mention, however, that Messrs. Fleming & Ferguson have now in hand engines of a similar type, which are to indicate 1,800 H.P.

Referring to our illustrations, fig. 1 is an end elevation, fig. 2 a front elevation, and fig. 3 a plan. It will be seen

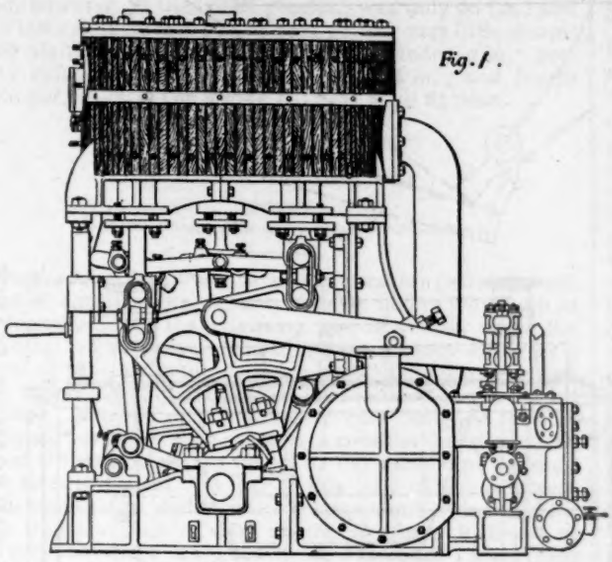


Fig. 1.

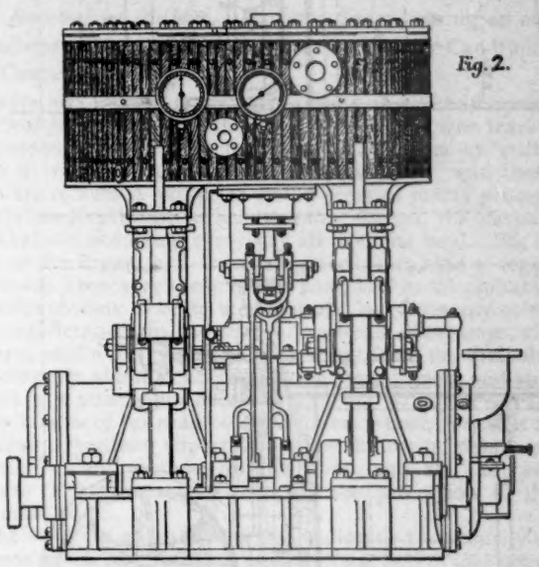


Fig. 2.

QUADRUPLE-EXPANSION ENGINE FOR SMALL STEAMER.

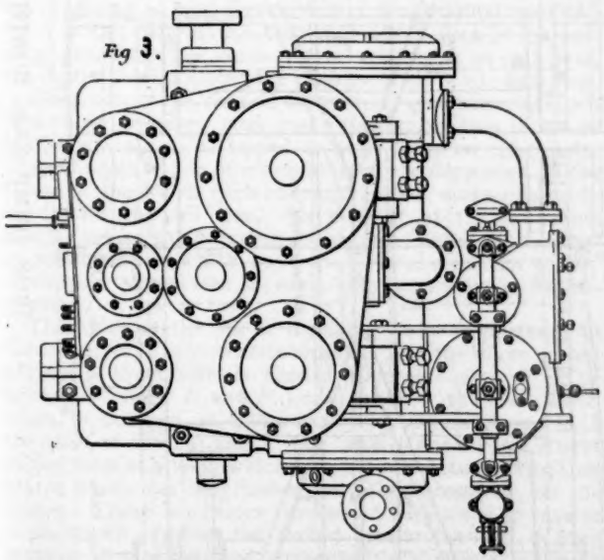


Fig 3.

that the arrangement is peculiar, all the cylinders being placed on one level. The advantage in getting a lower engine will be at once apparent, and this at least should be a very desirable feature in applying these engines to war-ships. As neither of the two piston-rods of each pair of cylinders can be over the crank-shaft, the axis of which is in the usual place in the middle of the engine-bed, the ordinary connecting-rod is replaced by a steel casting, as shown in fig. 1. Attached to the crosshead of each piston-rod is a link, the lower end of these links being attached to the triangular steel casting which takes the place of the connecting-rod. The lower end of the casting has brasses in which the crank-pin works in the usual way. There is a lever, or rock arm, which pivots on a pin in the engine framing, the other end being attached to a pin on the connecting piece as shown in fig. 1. In the engine in question a prolongation of this arm is used to work the air pump, etc. The two pistons of each pair of cylinders ascend and descend not quite together, one being a little in advance of the other. Consequently there is no dead center for either crank.

The sequence of the cylinders will be seen from the plan, fig. 3. Steam is admitted to the high-pressure cylinder by means of the piston-valve placed between the first two cylinders. The steam passes first into the space between the flanges of the valve, and not into the steam-chest. From thence it is admitted to the cylinder through the center cylinder port, and, having done its work, exhausts into the casing. It must be now explained that the valves to each pair of cylinders are placed one above the other on one valve-rod, and work in one steam-chest common to both. It will be seen, therefore, why it is necessary for the boiler steam to be admitted inside the valve, or, in other words, between the flanges, as otherwise the high-pressure steam would pass into the second cylinder as well as the first, the valve-chest space being common to both valves and cylinders. The steam escaping from the first cylinder fills the valve-chest, and is admitted to the second cylinder in the usual way, the exhaust this time being carried by the inside of the valve. Steam is then taken to the two next cylinders, and the same action is gone through once more, until the steam escapes to the condenser in the usual way.

The valves are worked by eccentrics and reversed by link motion, but the arrangement is necessarily peculiar. The valves for the third and fourth cylinders are placed directly over the crank-shaft, and can be worked from eccentrics in the usual way. The valves for the first and second cylinders, however, are considerably on one side of the fore-and-aft center line. In order to work the valve-rod common to these, an arm or connecting-rod is taken from each of the eccentric straps, and these arms work the link motion by means of a bell-crank lever attached to the engine-bed. In fig. 1 the arm of one eccentric can be plainly seen together with the bell-crank lever, and the connecting-rod carrying the motion to the solid bar link. The reversing links are placed one immediately in front of the other, and are pulled over by one lever and drag links. It will, therefore, be seen that only two eccentrics are used for all four cylinders, and only one would be required in a non-reversing engine.

The standards of the engine are used as crosshead guides, and the rubbing surface is less than usual, but with the arrangement of connection between crosshead and crank-pin here shown, the side thrust is very small, and there is little wear on the slipper guides.

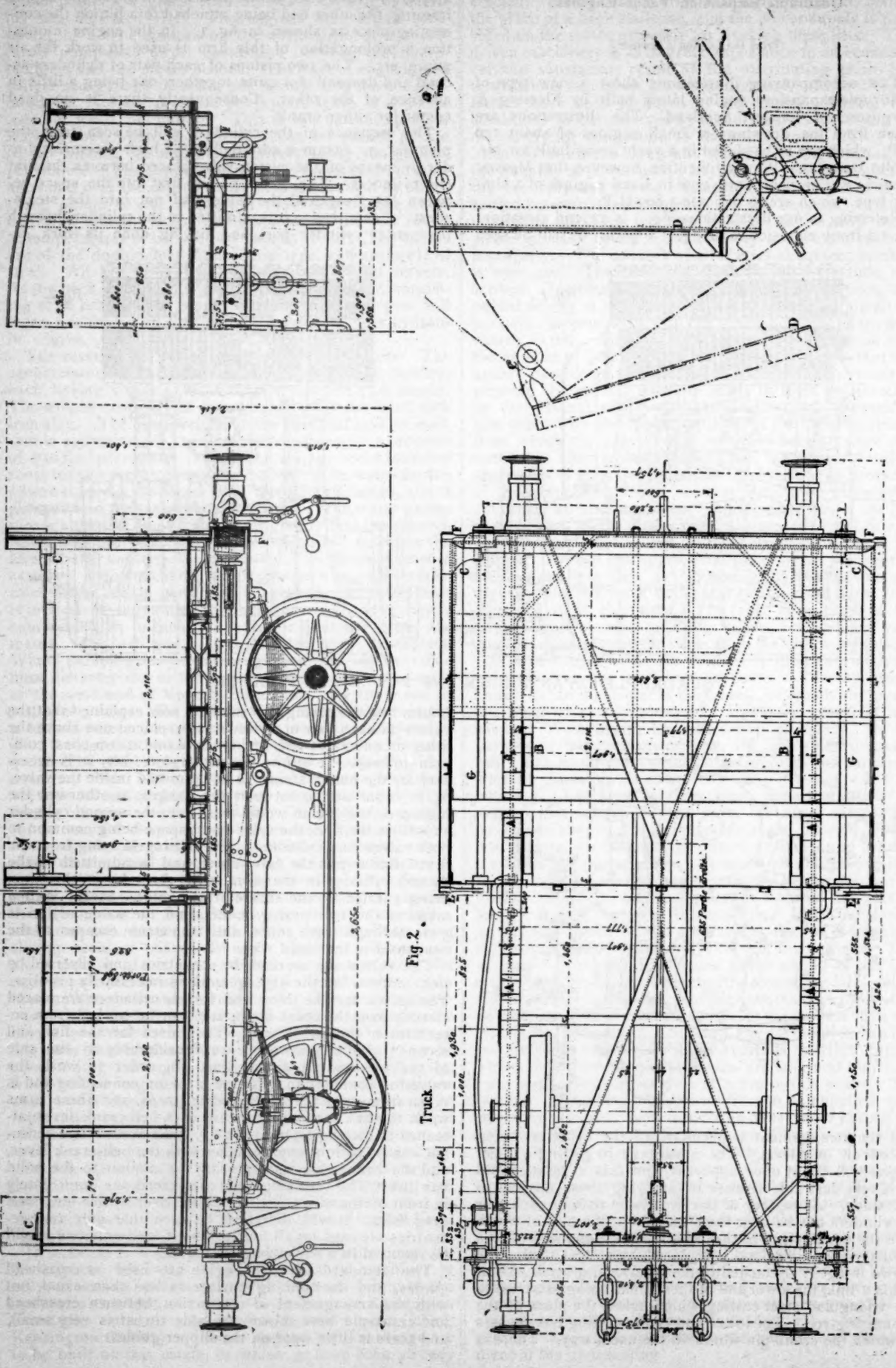


Fig. 2.

IRON DUMP CAR, NORTHERN RAILROAD OF FRANCE.

The advantages the makers claim for this design of engine are, that free access is offered to each cylinder, less fore-and-aft space is taken up, and also less height. There are fewer wearing parts and less attention in running is required, consequently a cheaper upkeep is obtained. The two cranks being placed directly opposite each other give a balance of moving parts. It is also claimed that the turning action of the four pistons on the crank-shaft is equal to four cranks at right angles.

These engines are, we are informed, designed to work at a pressure of 180 lbs. to the square inch, and have been run light at 400 revolutions per minute. We had an opportunity of seeing these engines at work at Messrs. Fleming & Ferguson's works a few days ago, and they certainly ran very smoothly and pleasantly. The test was not a fair one, however, as the boiler pressure was only 60 lbs., and the last cylinders could have been getting very little steam. The diameters of cylinders are, first cylinder, 7 in.; second cylinder, 9 in.; third cylinder, 12½ in.; and fourth cylinder, 18 in. The stroke is 12 in. in all of them.

A French Iron Coal Car.

(From the *Portefeuille Economique des Machines.*)

FOR a long time there have been used for carrying coal, cars of considerable capacity having bodies which tip in order to facilitate the unloading and in certain cases the loading. The body is raised up at one side either by a lever or by a hydraulic cylinder, and the opposite side can be opened in order to allow the contents of the car to escape. The different classes of cars designed for this purpose resemble each other to a considerable extent, the chief difference usually being in the method of opening the sides of the car. A car of this kind, which is of very excellent design, and of which a large number are used for the transportation of coal on the Northern Railroad of France, has been designed by M. Malissard-Taza; these cars are built in the Taza-Villain shops at Anzin.

The accompanying illustration shows one of these cars, fig. 1 giving a half elevation and longitudinal section; fig. 2 a half plan of the body and a half plan of the running gear; fig. 3 a cross-section, and fig. 4 an end view, the dotted lines showing the position of car while dumping.

The frame of the car and the running gear are very much like those of other coal cars; they carry two boxes or bodies which can be tipped so as to dump on either side. These bodies, made of wrought iron, are supported on the frame of the car at each end and by two cross-sills made of double channel iron. On the side of the car frame under each of the dumping boxes are fixed four iron lugs *A*, the inside of which have the form of a quarter circle. These are placed two on each side, as shown in the engraving.

The sides of the box or dumping body are fastened to the upper edge by eccentric hinges *C*; on the lower corner of each of these boxes is fixed a triangular piece *D*. The latches or dogs *E* and *F*, keyed upon a shaft *G*, catch when in position on these triangular pieces *D*, and hold the sides of the car shut. The latch *F* has a vertical arm in the form of a fork, which hangs down between two iron plates fixed, one lengthwise, the other crosswise, on the frame. These two plates are pierced with a slot to receive a pin which prevents the forked arm of the latch *F* from leaving its position, and consequently prevents the latch from letting go.

To open one side of the box the pin is lifted and the longer branch of the fork *F* is turned back, this causing the shaft *G* to turn and lift the latches from the triangular pieces *D*. If the opposite side of the box is then raised the door opens on its hinges *C* and allows the contents of the box to pass out. The action is very clearly shown by the dotted lines in fig. 4.

When the box is empty it is lowered back into a horizontal position; the side or door then falls shut, and the latches fall into their places; the pin is then replaced in the fork *F*. This pin, upon which dependence is placed to hold the sides of the wagon, is so arranged that in case it should not be properly locked it will still keep it in place by gravity, and it is not likely to be shaken out by the motion of the car.

The car which we have just described is made entirely of iron, weighs 13,200 lbs., and carries 22,000 lbs. of coal. It has been adopted by the Northern Railroad Company, and a large number of the same pattern are also owned by mining companies which ship their products over that road.

Legislative Prevention.

WE reproduce below the last editorial written before his death by Mr. James Gillet, late editor of the *National Car and Locomotive Builder*. It has a direct bearing on one prominent subject of discussion at the Master Car-Builders' Convention this year.

There are a great many crying evils in railroad operation which imperil the safety of every person who travels on passenger or freight trains, or who crosses or walks upon a track, or is employed in track-yards; and these evils are of such a nature as would seem to justify prompt legislation to prevent, at least to some extent, the casualties that are occurring every day all over the land. But in spite of the urgent and increasing need, this kind of legislation has been very tardy in the past, and in all probability will continue to be so in the future, not from any criminal indifference on the part of railroad companies, the general public or legislative bodies, but from the difficulty of bringing about concerted action based upon and sustained by a unanimous public sentiment. We have a great many boards of railroad commissioners whose duty it is to exercise a vigilant supervision over the roads, point out defects in their methods of operation, and aid the lawmakers in framing enactments for the protection of the community.

The subjects which involve more directly the security of persons in life and limb are freight-train brakes and couplers, grade crossings, the construction of bridges and trestles, and the heating of cars. Many more might be named, but these are the most prominent from the fact that they have been talked about until their discussion has almost become wearisome from repetition. Commissioner Coffin, of Iowa, whose efforts to mitigate the perils to which trainmen are exposed have been earnest and unremitting, says in a special report that there is no longer a particle of excuse for delay in compelling railroads to use power brakes and a self-coupler of the Janney type on freight trains. The report of the Massachusetts Commissioners reiterates what nobody denies, that grade crossings are dangerous on single tracks and more so on double tracks, and should be abolished along with the private crossings, which are also very numerous in the State. Bridges of bad design and faulty construction are referred to in terms of emphatic condemnation; but in regard to car heating, no definite recommendation is made, although considerable space is devoted to the subject. The brake and coupler questions, it may be said, are not just now in a shape for legal interference, and as respects car heating, the results of experiments during the past winter are awaited to enable legislators to act intelligently in dealing with the subject. . . . There is no danger of a popular uprising to wipe all the railroads out of existence in order to insure safety in traveling, and have an end of the sickening horrors that are now paraded every few days on newspaper bulletins. The members of legislative bodies of the average sort, when dealing with these subjects, are apt to be swayed by conflicting interests and opinions. The safety of trainmen and passengers is professedly the paramount object to be attained, but it is liable to be lost sight of or overslaughed by outside pressure, or the possible danger of legislating a fortune incidentally into the coffers of individuals or companies who happen to control the patents. Or, in case no patents are involved, the law-making Solons may become perplexed upon questions of expediency as to what is really the best thing to do, especially when such questions are raised by railroad companies themselves in regard to the proposed legislation.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

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(Continued from page 277.)

CHAPTER XIII.—*(Continued.)*

THE VALVE GEAR.

QUESTION 331. *How is the motion of either eccentric communicated to the valve?*

Answer. The ends of each pair of eccentric-rods are connected together by a link, *a b*, figs. 197 and 198. This link has a curved groove or slot, *k*, in it, in which a block, *B*, fits accurately, so that it can slide freely from one end to the other. This block is attached to the lower rocker-arm, *N*, by a pin, *c*, fig. 198, which works freely in the block. The two eccentric rods *C* and *D* are attached to the ends of the link at *e* and *f* by pins and knuckle-joints. It is apparent that if the link is down, or in the position shown in fig. 198 and also in the diagram, fig. 199, on a smaller scale, the motion of the upper eccentric-rod, which is usually used for the forward motion, will be imparted to the rocker, and thus to the valve, and when the link is in the position shown in fig. 200, that the valve will be moved by the lower or backward eccentric-rod *D*. In order to reverse the engine, it is then only necessary to provide the means of raising and lowering the link. This is done by a shaft, *A*, fig. 198, called a *lifting-shaft*, which has two horizontal arms, *E*,* one for each link, and a vertical arm, *F*. Each link is suspended from the end of one of the horizontal arms by a rod or bar, *g h*, called a *link-hanger*, which is connected to the link and to the arm above by pins, *h* and *g*, which enable the hanger to vibrate freely. The lower pin is attached to a plate, *o p*, called a *link-saddle*, which is bolted to the link. The vertical arm, *F*, of the lifting-shaft is connected by a rod, *G G*, called the *reverse-rod*, to a lever 20 21, IV and V, in the cab called a *reverse-lever*, the construction of which will be explained hereafter. This lever is worked by the locomotive runner, and by moving the upper end of it forward, the link will be lowered into the position shown in fig. 198, and also in the diagram, fig. 199, and the rocker and valve will then be moved by the forward eccentric; and if the reverse-lever is moved back, the link will be raised into the position shown in fig. 200, and the backward eccentric will then move the valve. When this is done, the valve-gear is said to be thrown into the *forward* or *backward motion*, or *forward* or *back gear*.

QUESTION 332. *How is the steam made to work more or less expansively?*

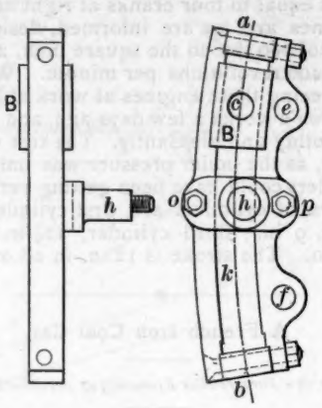


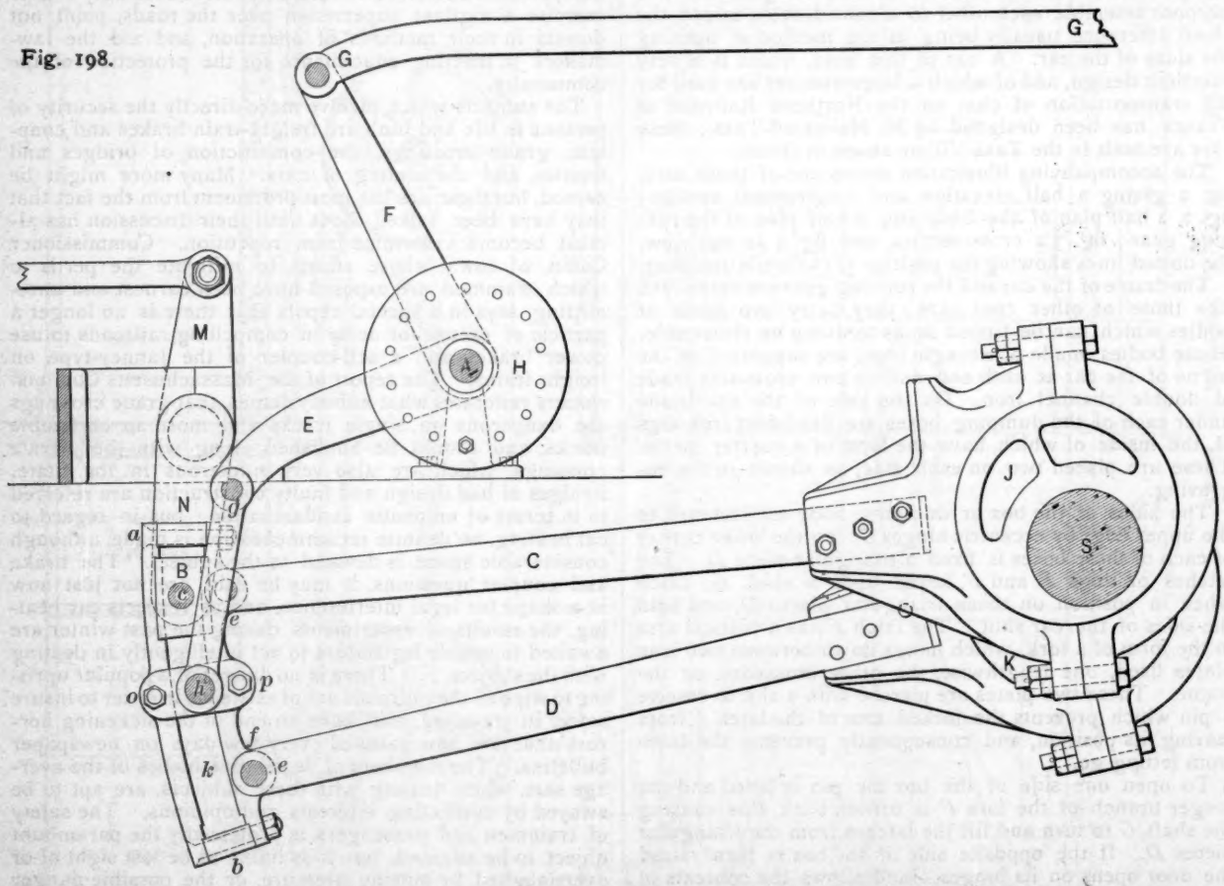
Fig. 197.

Answer. By changing the travel of the valve.

QUESTION 333. *How is the travel of the valve changed?*

Answer. By either raising or lowering the link, so that the link-block and rocker-pin will be some distance above or below the eccentric-rods. Thus in fig. 199, the motion of the upper eccentric-rod, and in fig. 200 that of the lower or *back* eccentric-rod is communicated to the rocker-pin and the valve. If, however, the link should be raised so that the link-block and rocker-pin are somewhat below the upper or forward eccentric-rod, as shown in fig. 201, then the motion imparted to the rocker and valve will partake somewhat of that of the upper and also of the lower eccentric-rod. So long as the rocker-pin is above the center of the link, the motion of the valve will partake most of that of the upper or forward rod, and the engine will then run forward; but when the rocker-pin is below the center of the link

Fig. 198.



* Only one of these is shown in the engraving.

its motion will be influenced more by the back eccentric-rod, and the engine will then run backward.

The motion of the link, which is somewhat complex and difficult to understand clearly, will perhaps be understood better if we represent it in a number of successive positions of the whole stroke of the piston, as was done to show the motion of the eccentric in figs. 15 to 28. We will therefore suppose that the link is in what is called *full gear forward*, as shown in figs. 203 and 214. In fig. 203 the link is in the position it would occupy when the piston is at the beginning of its stroke; in fig. 203 it is in that which it will be in when the piston has moved four inches; in fig. 205, when it has moved eight inches; in fig. 206, twelve; and in figs. 207, 208, and 209, sixteen, twenty, and twenty-four inches. Figs. 209 to 214 represent the successive positions of the link during the return stroke.

In these figures the center-line of the slot in the link is represented by dotted lines, which are indicated by numbers preceded by a — or + sign. The numbers represent the distance that the piston has moved from the beginning of the stroke, when the link is in the position shown and the — sign indicates the backward stroke of the piston, and the + sign its forward

Fig. 199.

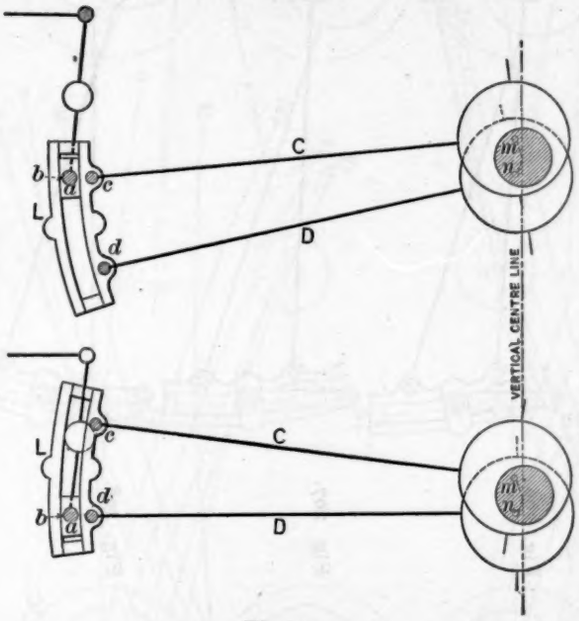


Fig. 200.

stroke. Thus in fig. 204 the figures — 4 — 4 indicate the dotted center-line, and also designate that the piston has moved 4 in. from the beginning of its backward stroke; when the link is in the position represented, and — 8 — 8, in fig. 110, that it has moved 8 in. of its backward stroke. To show the action of the link, the successive positions of the center-lines represented by figs. 108 to 119 have been laid down on a larger scale in the diagram, fig. 215. For greater clearness the center-lines are represented in full instead of by dotted lines, and are indicated by the same signs and numbers in the diagrams, fig. 215, that were used in figs. 203 to 214.

O, fig. 215, represents the rocker-shaft, and the dotted circles *a* and *b* two positions of the lower rocker-pin. As the center of the rocker-pin must always coincide with the center-line of the link, it is evident that the action of the link, as shown by figs. 203 to 214, will move the rocker-pin from *a* to *b*, fig. 215, a total distance equal to 5½ in.

If, however, the link was raised up into the position shown in fig. 201, so that the rocker-pin is half-way between the end of the eccentric-rod and the center of the link, then the action of the link in relation to the rocker would be as represented in fig. 216, in which the different positions of the center-line of the link and of the rocker have been laid out with the link raised up for *half-gear*, as it is called, in the same way as was done for full-gear before. From this it will be seen that the travel, *a b*, imparted to the rocker-pin and valve by the link when it is in the position shown, instead of being 5½ in. is now only 3¼ in. In fig. 202 the link is represented in the position it would be in when it is raised up, so that the rocker-pin would be in the center of it or midway between the eccentric-rods. This position is called *mid-gear*. The successive positions of the center-line of the link in this position have been laid down in fig. 217 in the same way as was done for full and half-gear. The movement of the rocker, it will be seen, is, for mid-gear, only 2¼ in.

These diagrams show that when the rocker-pin is opposite the eccentric-rod, the valve receives the full or more than the full throw of the eccentric,* and that the motion imparted by the eccentric diminishes as the rocker-pin approaches the center of the link, so that, with eccentrics having 5 in. throw and a valve with ¼ lap and ⅛ in. lead, we can increase or diminish the travel of the valve from 2¼ to 5½ in. by simply raising or lowering the link, which is done by the reverse-lever.

Question 334. *What is the effect of this variation of travel on the working of the valve and the admission and release of steam to and from the cylinder?*

Answer. It is almost precisely the same as that which is effected by increasing or diminishing the throw of the eccentric, which was explained in the answer to question 121. In order to show this effect more clearly, we have represented by motion-curves, fig. 218, the movement imparted to the valve by the link when it is in full, half, and mid-gear, as illustrated in the preceding figures. The curve for full-gear is engraved in

Fig. 201.

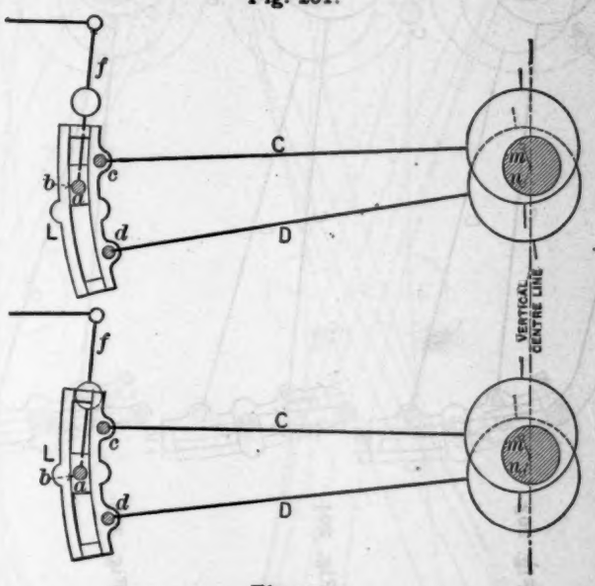


Fig. 202.

full heavy lines; that for half-gear, in lighter lines, and for mid-gear, in dotted lines.

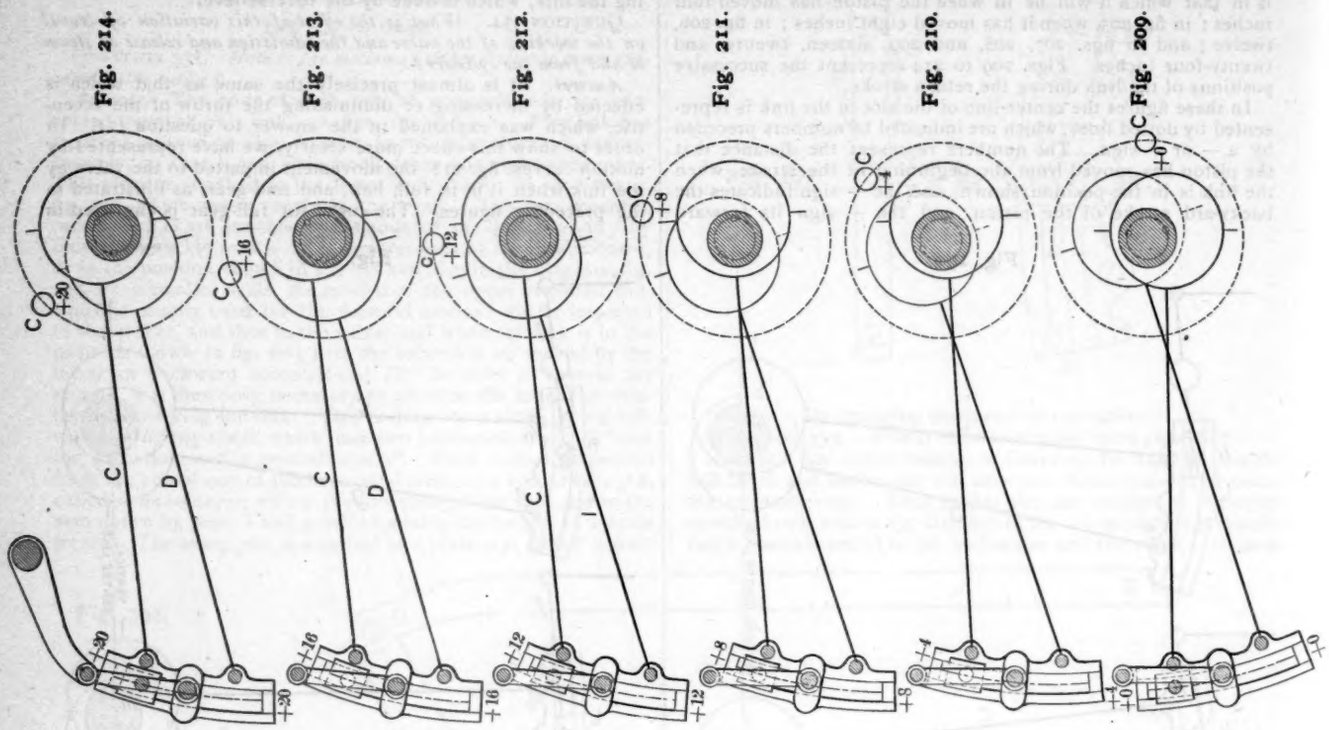
Question 335. *What may be learned from these motion-curves?*

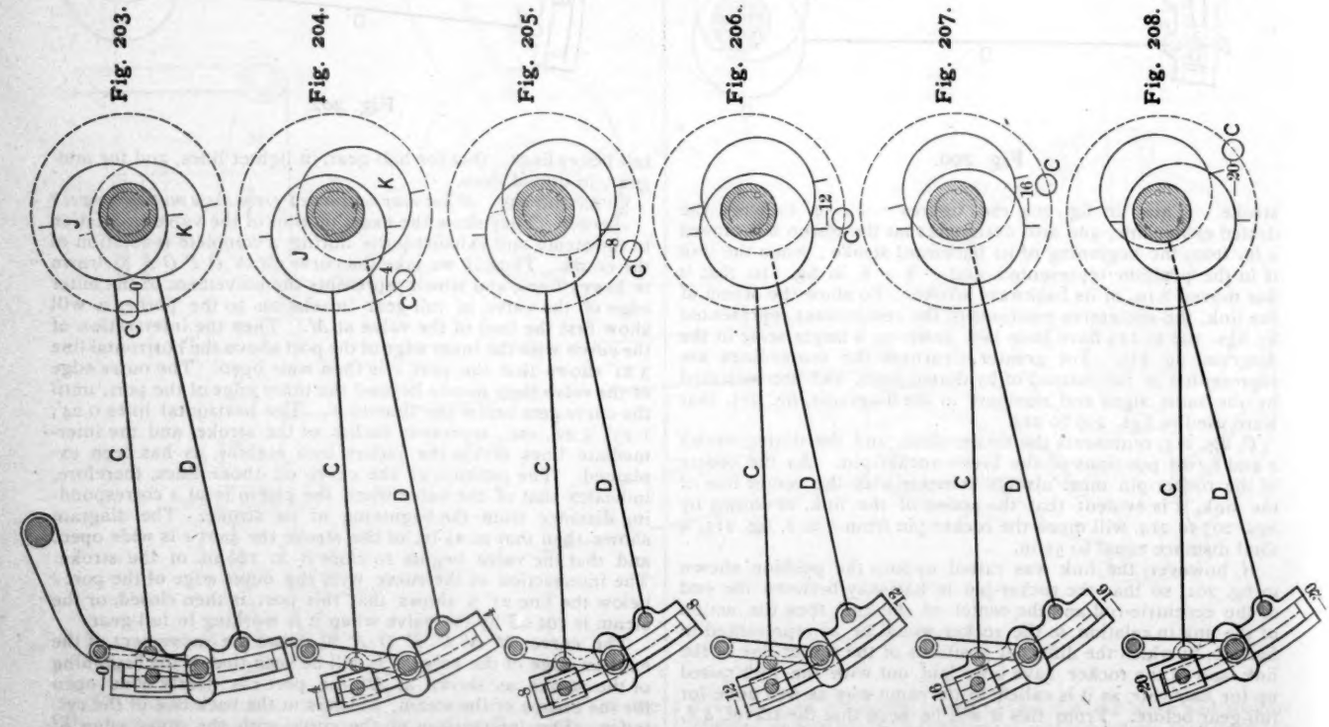
Answer. They show the exact motion of the valve in relation to the steam and exhaust-ports during a complete revolution of the crank. Thus, if we take the curve *M N O P Q R S*, drawn in heavy lines, and which represents the movement of the outer edge of the valve in full-gear in relation to the port *c*, it will show first the lead of the valve at *M*. Then the intersection of the curve with the inner edge of the port above the horizontal line 3 21′ shows that the port *c* is then wide open. The outer edge of the valve then moves beyond the inner edge of the port, until the curve gets below the line 16 8′. The horizontal lines 0 24′, 1 23′, 2 22′, etc., represent inches of the stroke, and the intermediate lines divide the inches into eighths, as has been explained. The position of the curve on those lines, therefore, indicates that of the valve when the piston is at a corresponding distance from the beginning of its stroke. The diagram shows then that at 2¼ in. of the stroke the port *c* is wide open, and that the valve begins to close it at 16½ in. of the stroke. The intersection of the curve with the outer edge of the port *c* below the line 21′ 3′ shows that this port is then closed, or the steam is cut off by the valve when it is working in full-gear.

The curve *M′ N′ O′ P′ Q′ R′ S* shows the movement of the exhaust edge of the valve. It will be seen that at the beginning of the stroke, as shown at *M′*, the port *e* is nearly wide open for the escape of the steam, which is in the back end of the cylinder. The intersection of the curve with the outer edge of

* When the block is opposite the eccentric-rod at the beginning of the piston stroke, the link moves it a distance somewhat greater than the throw of the eccentric, owing to the fact that when the link assumes the inclined position shown in figs. 206 and 207 the block slips upward in the link slot. This slip of the block is, however, dependent on the way in which the link is suspended.

the port a little below the line 20 4′ shows that the valve has then commenced to close the port *e*, and another intersection with the inner edge below the line 23 1′ indicates that it is entirely closed before the piston has reached the end of the cylinder. The steam which remains in it when the valve closes is then compressed by the piston as it advances to complete its stroke. For this reason the point where the valve closes the port to the exhaust is called the *point of compression*. If we follow up the reverse side of the curve it will be seen that it intersects the inner edge of the port *e* at *Z* or near the line 1 23′.





This shows that the port *e* is opened to the exhaust before the piston has completed its stroke. This is called the *point of pre-release*.

In the same way we may follow the curve *M n o p q r S*, which shows the movement of the valve in mid-gear. It shows that steam is then cut off at about 15⅝ in. of the stroke, and that at no time is the port wide open. The curve *M′ n′ o′ p′ q′ r′ S′* shows that the valve begins to close the exhaust-port *e* to the exhaust at about 12 in. of the stroke, and that compression begins at about 21½ in. The intersection of the opposite side of this curve with the inner edge of the port *e*, at *z*, shows that *pre-release* or exhaust begins while the piston must still move 3½ in. to complete its stroke.

The dotted lines *M S* and *M′ S′* show the motion of the valve in mid-gear, and the curve then becomes a straight line. Steam is then cut off at 3 in. of the stroke, and the exhaust-port is closed at 13½ in. The greatest opening of the steam-port, for the admission of steam, is then no greater than the lead.

It is of course possible to work the link in any intermediate position between those which we have represented.

QUESTION 336. *What is the greatest and the least admission of steam possible with the ordinary link motion?*

Answer. With 24 in. stroke of piston and 5½ in. travel and ¾ in. lap, steam can be admitted as shown by the motion-curves during 21½ in. or nearly 90 per cent. of the stroke, and can be cut off at about 3 in. or 12½ per cent. It will be seen, however, that in mid-gear the *pre-admission* of steam—that is, the admission of steam before the piston reaches the end of the stroke, is equal to that admitted after, so that it is impossible to work the locomotive with the link in that position. Practically it is found that little useful work can be done with a link if the steam is cut off at less than six inches, or one-fourth of the stroke. Even then the opening of the steam-ports is so small that the steam which enters the cylinders is very much wire-drawn.

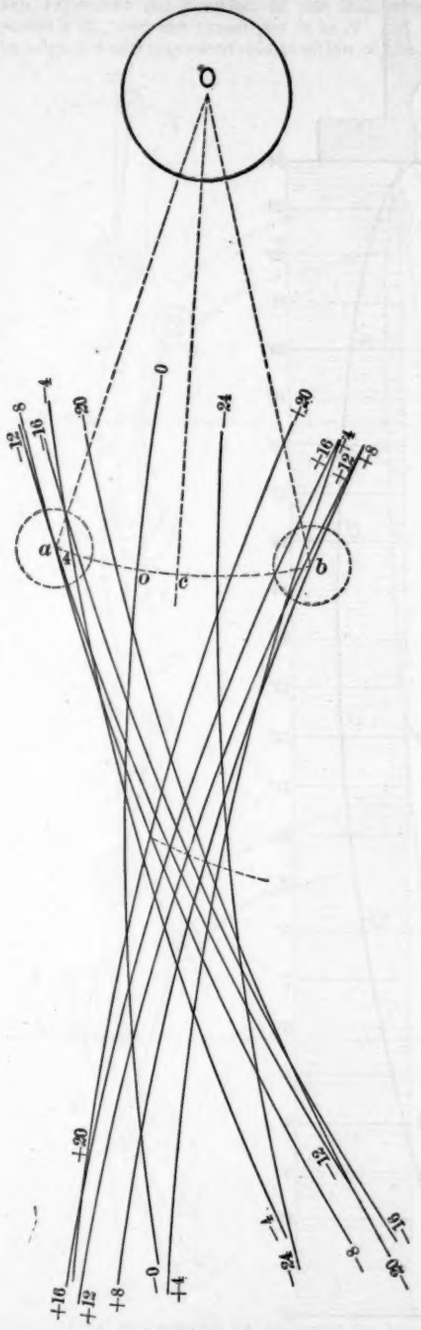


Fig. 215.

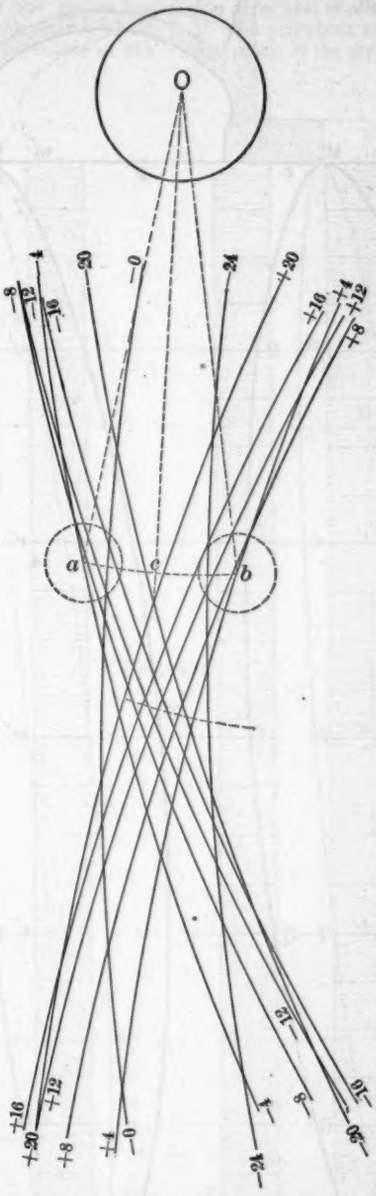


Fig. 216.

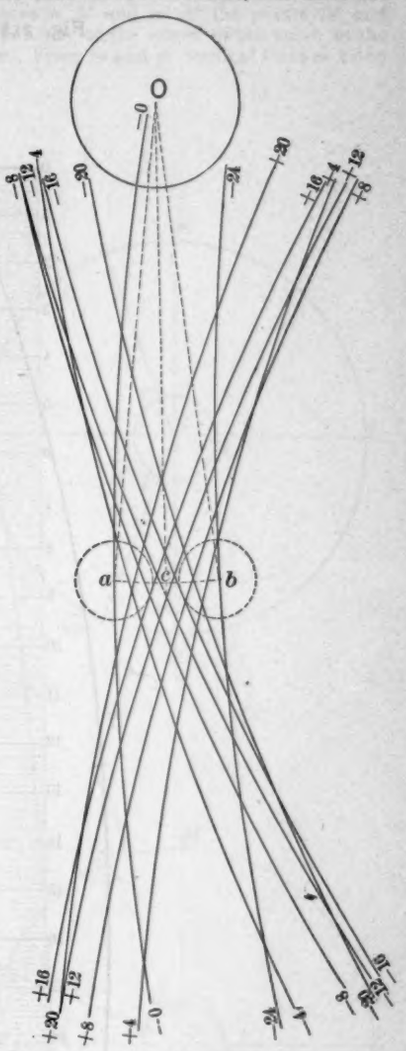


Fig. 217.

QUESTION 337. *How are the curves drawn which represent the motion of the valve?*

Answer. These motion-curves as produced by the link-motion are difficult to draw, as the motion of the link is very complicated. It is doubtful, therefore, whether those who have no knowledge of mechanical drawing will be able to understand the following description of the method of doing it.

In the first place, the center *S*, fig. 219, of the axle, *O* of the rocker and *A* of the lifting-shaft must be laid down in their proper positions. If, now, the valve has ¾ in. lap and $\frac{1}{16}$ lead, it must be $\frac{13}{16}$ in. from its middle position, and the lower rocker-pin, *c*, must be the same distance ahead when the piston is at the front end of the cylinder and at the beginning of the backward stroke. We will, therefore, mark the center, *c*, of the rocker-pin that far ahead of the vertical center-line *m n*, which represents the central position of the rocker.

If from the center of the axle a circle, *o p q*, be drawn, whose diameter is equal to the throw of the eccentrics, this circle will represent the path in which the centers of the eccentrics will revolve.

Another circle, *H I J N*, whose diameter is equal to the stroke of the piston, should be drawn from *S* as a center to represent the path of the center of the crank-pin. If the distance from the center *S* of the axle to the center of the lower rocker-pin, *c'*, when the latter is in its middle position, be taken for a radius, and from the position *c* of the rocker-pin, at the beginning of the stroke, as a center, the circle representing the path of the eccentrics be intersected at two points, *o* and *p*, the points of intersection will represent the positions of the centers of the forward and backward eccentrics at the beginning of the stroke of the piston. Having determined these positions, lay off a distance *c e*, from *c*, the center of the rocker-pin, equal to the distance *c e*, fig. 197, of the center-line of the link from the center of the pin *e*, by which the eccentric-rod is connected to the link. Then the distance *e o*, fig. 219, will be the length of the eccentric-rod. With the distance as a radius

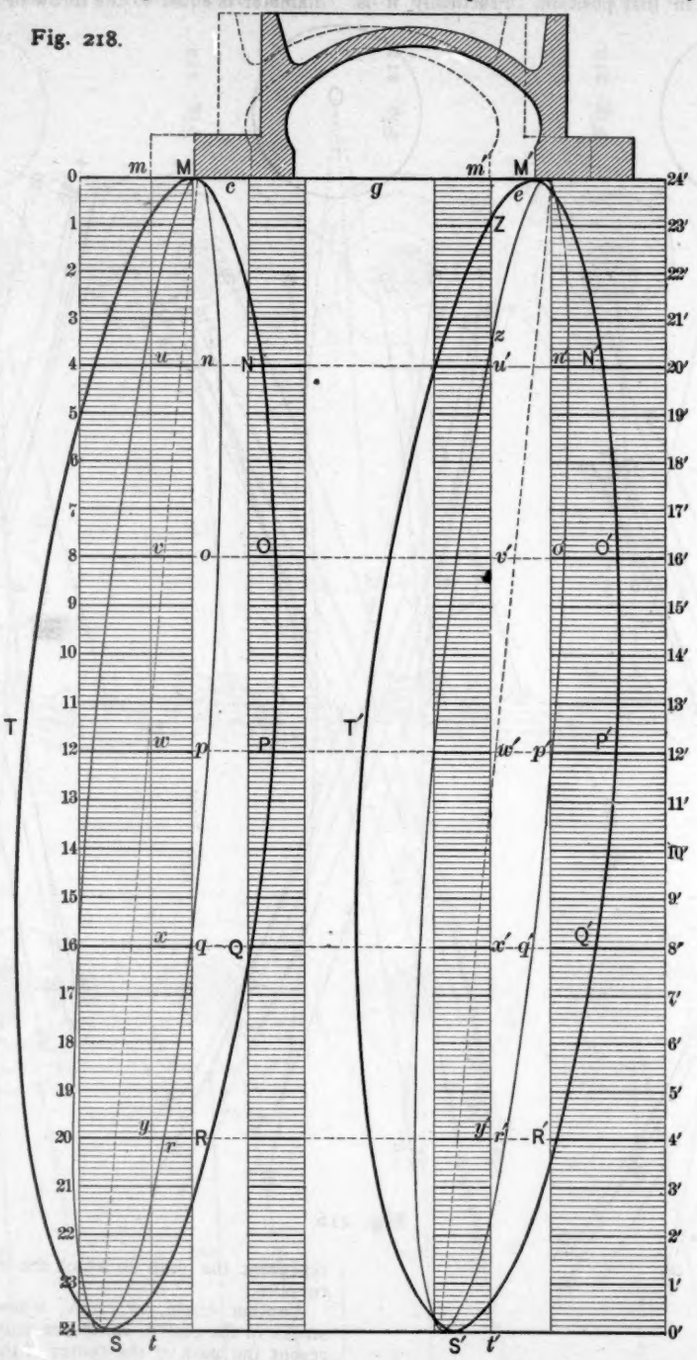
and o and p as centers describe two arcs 1 2 and 1′ 2′. Having laid down the position of the lifting-shaft A with $A\,g$, equal to the length of the lifting-arm E, describe an arc 3 4. As the link is suspended from g by the hanger $g\,h$, which oscillates from the end g of the lifting-arm in the arc 5 6, and as the lifting-arm, for any one point of cut-off, is stationary, therefore the point of suspension of the link must always be on the arc 5 6 described from the center of the pin g in the lifting-arm, with a radius equal to the length of the hanger. As the eccentric-rods are connected to the link by pins e and f, their centers must always coincide with the arcs 1 2 and 1′ 2′ described from the centers of the eccentrics by the length between the centers of the eccentric-rods as a radius.

To locate the position of the link, a drawing like fig. 197 should be made on a thin board or a stiff piece of paper. Then cut away the portion on the left of the center-line $a\,b$, as shown in fig. 221, so as to leave an exact outline of the center-line of the link. Draw lines through the centers e and f of the pins by which the rods are attached to the link, and cut off the portion on the right-hand side of these lines. As the center of suspension is usually back of the middle of the link, a notch should be made on the front side, as shown at h. Having cut the board or paper accurately to the form of the link, lay it on the drawing, fig. 219, so that the centers e and f will be on the arcs 1 2 and 1′ 2′, and the center of suspension, h, will be on the arc 5 6. When these three points coincide with the three arcs, the template will be in the position that the link would occupy when it is suspended from the point g, and the centers of the eccentric are in the position shown. When the position of the link is thus determined, draw a line on the edge $a\,b$ to represent the center line of the link in that position.

Another position of the link may be laid out as follows: by the method described in answer to question 117, lay down the position N', fig. 220, of the crank-pin when the piston has moved any distance, say 4 in. of its stroke. Lay out the position of the centers o and p of the eccentrics the same as in fig. 219, and draw lines $S\,o\,7$ and $S\,p\,8$ from the center S of the axle through the centers o and p and intersecting the circle $H\,I\,J\,N$ at 7 and 8.

Now, the crank-pin turns from N to N', while the piston is moving 4 in. from the front end of the cylinder. This is called its *angular motion*. As the crank and eccentrics are all fastened to the axle, they must all have an equal angular motion while the crank-pin is moving from N to N'. Therefore, if with a pair of dividers we take the distance $N\,N'$ and lay it off from 7 to 9 and from 8 to 10, and draw lines from 9 and 10 to the center

Fig. 218.



S of the axles, the intersection of these lines at o' and p' with the circle $o\ p\ q$ will represent the angular motion of the eccentrics, while the crank-pin is moving from N to N', and o' and p' will be the position of the centers of the eccentrics when the crank-pin is at N'. From these centers, with the length of the eccentric-rods as a radius, describe the arcs 1 2 and 1′ 2′, as before. Draw the arc 5 6 as in fig. 219, and then lay the template of the link on the drawing, and make its centers, *k e* and *f*, coincide with these arcs as before, and it will then represent the position of the link when the piston has moved 4 in., and the crank-pin is at N'. A line drawn along the edge *a b* will represent this position of the center-line of the link. This process can be repeated for successive positions of the piston and crank-pin.

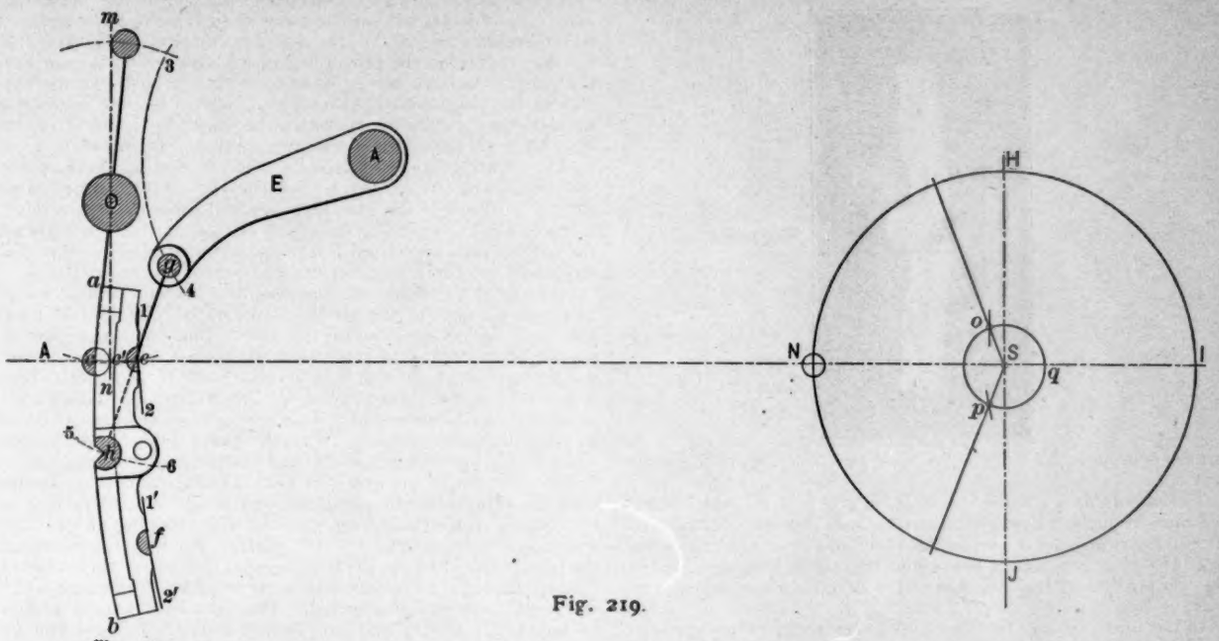


Fig. 219.

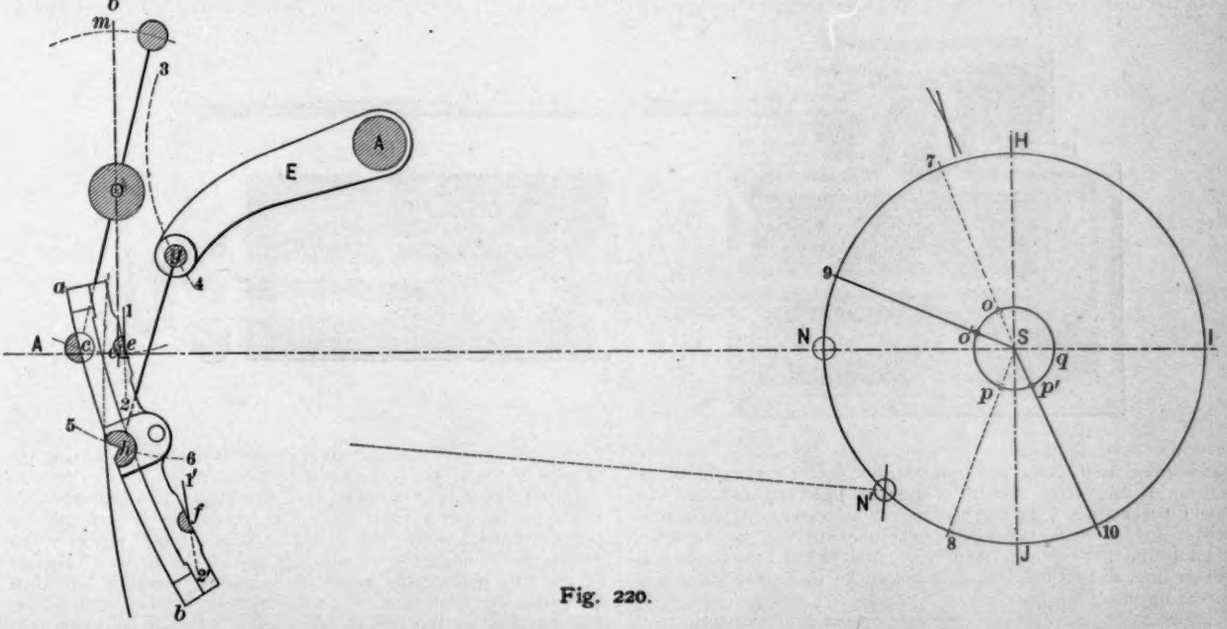


Fig. 220.

Such diagrams as have been described should be drawn to a larger scale than the engravings—preferably full size—and great care must be taken to lay them out with the greatest precision. A thin white pine board—about $\frac{3}{32}$ in. thick—is the best material to make the template of the link of. Great care must be taken to make the outline *a b* so as to conform accurately to the center-line of the link.

QUESTION 338. *Having laid out the successive positions of the link, as shown in figs.* 215–217, *how are the motion-curves, fig.* 218, *drawn from them?*

Answer. In fig. 215 the arc *a b* represents the path of the center of the rocker-pin, and the dotted line *O c* the middle position of the lower rocker-arm. The distance of the point of intersection, *o*, of the line — *o* — *o* with the arc *a b* represents the movement of the valve from its middle position, when the piston is at the beginning of its backward stroke. In fig. 218 the dotted lines *m m′* represent the valve in the middle of the valve-face, the lines *m* and *m′* representing the outer or steam edge and the inner or exhaust edge of the valve. As the valve will be moved a distance equal to *o c*, fig 215, from its middle position when the piston begins its stroke,* and as this movement is reversed in direction by the rocker, if we lay off on the right side of *m* and *m′* distances *m M* and *m′ M′* the points *M* and *M′* will represent the position of the edges of the valve at the beginning of the stroke. From *m* and *m′* vertical lines *m t* and *m′ t′* are drawn to represent the position of the two edges of the valve when it is in the middle of the valve-face for all points of the stroke.

Proceeding as before in fig. 215, the distance of the point of intersection 4, of the line — 4 — 4, with the arc *a b*, 4 *c*, represents the movement of the valve from its middle position when the piston has moved 4 in. of its stroke. Taking this distance and laying it off from the vertical lines *m t* and *m′ t′* on the horizontal line 4 20′, fig. 218, we locate the points N and N' which represent the positions of the steam and exhaust edges of the valves when the piston has moved 4 in. In the same way the distance from *c* of the intersections of the lines — 8 — 8, — 12— 12, — 16 — 16, etc., in fig. 215, with the arc *a b* can be

* This will be the case when the two arms of the rocker are of the same length, as they usually are. Sometimes they are of different lengths.

laid down on the horizontal lines 8 16′, 12 12′, 16 8′, etc., in fig. 218, and the points *O P Q*, etc., and *O′ P′ Q′*, etc., are thus located. The curves *M N O P Q R S* and *M′ N′ O′ P′ Q′ R′ S′* can then be drawn through these points either by hand or by constructing templates, and the intersection of these curves with the intermediate horizontal lines in fig. 218 will represent the position of the steam and exhaust edges of the valve in relation to the ports *c g* and *e* for any part of the stroke of the piston. The more points there are determined, the more accurate will be the curves. It is, therefore, best to lay down the position of the valve for each inch of the stroke of the piston. The curves

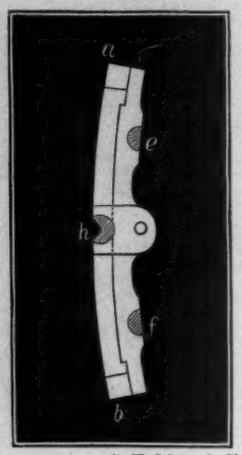


Fig. 221.

can be completed by drawing *S T M* and *S′ T′ M′* in the same way.

The curves *M n o p q r S* and *M′ n′ o′ p′ q′ r′ S′*, which show the motion of the valve when the link is in half-gear forward or in mid-gear, may be drawn in the same way from the diagrams, figs. 216 and 217, which represent the successive positions of the center-line of the link when it is in half and mid-gear forward.

In the illustrations the upper and lower rocker-arms are represented as of the same length, as already explained; in some cases they are of unequal lengths, which of course affects the motion of the valve. In the diagrams, figs. 219 and 220, the lower rocker-pin, *h*, is represented as being on the horizontal center-line *A N I* drawn through the center *S* of the axle. Usually the lower rocker-pin is located below this horizontal center-line, so that the link will not strike the boiler when it is raised up into back-gear.

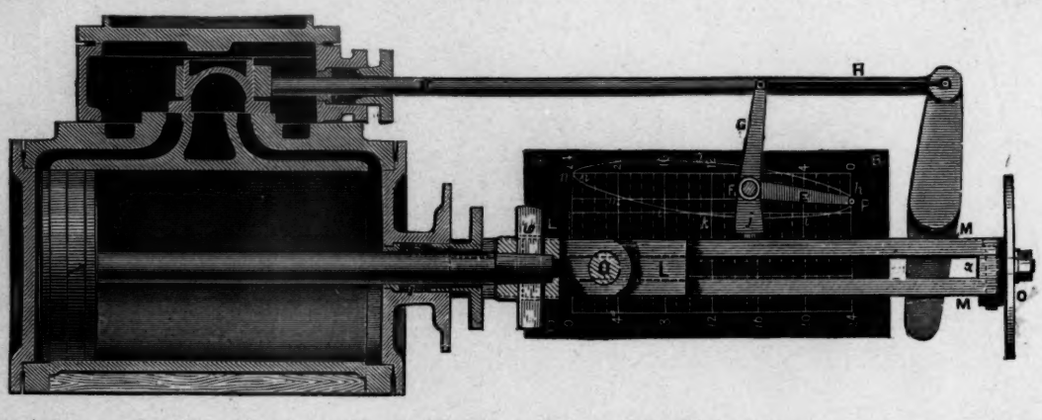
QUESTION 339. *Is there any other method of drawing these motion-curves?*

Answer. Yes; models which show the working of the valve-gear have been constructed, to which the reciprocating motion of the valve is imparted, and which traces a curve with a pencil on a surface having the same motion as the piston. This method has been employed by the writer in an instrument which he has applied to the locomotive itself. The principle upon which it works will be understood by supposing that the steam and exhaust-ports, as represented in the diagram for motion-curves, fig. 218, be drawn on a board, *A B C D*, fig. 222; but instead of standing vertical, as in fig. 218, they are represented in a horizontal position, and the board on which they are drawn is fastened to the cross-head *L*, so that the former will move backward and forward simultaneously with the latter and the piston. A small shaft, *F*, is attached to suitable supports, *j*, which are fastened to the guide-bars. This shaft has two arms, *G* and *E*, one vertical and the other horizontal and of the same length. The upper end of the vertical one, *G*, is then attached to the valve-stem or rocker-arm by a short connecting-rod, *H*, or other suitable means, so that the movement of the upper rocker-pin and the valve-stem will be imparted to the arm and shaft. The end *P*, of the horizontal arm *E* then has exactly the same motion vertically that the valve-stem and valve have horizontally, with the very trifling inaccuracy due to the fact that the movement of the one is in a straight line, whereas the other is in the arc of a circle.

Now if a pencil, *P*, is attached to the end of the horizontal arm *E*, and is set so that its point indicates the exact position of the steam edge, *M*, of the valve, as shown in fig. 218, it is obvious that when the piston and board have moved four inches, the pencil will have moved downward and have drawn the portion of the motion-curve from *h* to *i*; and when the piston has moved eight inches the curve will be drawn to *j*, and at 12, 16, 20, and 24 inches of the stroke the curve will be drawn to *k l m* and *n*. During the return stroke a corresponding curve, *n o h*, will be drawn. With such an instrument curves can be drawn for any position of the link, and they will show the exact movement of the valve during the whole stroke, and will indicate all the defects resulting from bad proportions or construction, lost motion in the parts, or other causes of error or irregularity.

In using this instrument, however, it is usually impracticable to attach a board to the inside of the cross-head, and it must therefore be fastened to the outside. The horizontal arm *E* should be made of thin steel, so as to form a spring. The end has a small *boss*,* *P*, with a hole in it $\frac{3}{16}$ in. in diameter. This hole has a screw-thread cut in it, into which an ordinary hard drawing-pencil is screwed. The spring is so arranged that the pencil will not be in contact with the board unless it be pressed against it. The locomotive is then placed on a smooth piece of track with steam on and run very slowly, so that a person walking alongside can press the pencil against the surface of the board, which should be covered with drawing-paper. By watching the cross-head when it reaches the end of the stroke, the pencil can then be pressed against the paper and kept in contact through the whole stroke and instantly released when the motion-curve is completed. The link can then be placed in another position, and thus any number of curves can be

Fig. 222.



drawn, which will furnish an accurate means of analyzing the motion of the valve.

In practice it is best not to draw the lines which represent the edges of the ports until after the curves are drawn and the paper removed from the board. A line must, however, be drawn on the engine from which to lay off the ports. This can be done by placing the valve in its middle position, and then fastening the shaft *F* with a nut which should be provided for that purpose on the end of the shaft. After it is fastened in this position, detach the connecting-rod *H*, and with one stroke of the piston a line can be drawn with the pencil *P*. This line will correspond with the vertical line *m t* or *m′ t′*, and from it the ports *c* or *e* can be laid off so that the motion-curves will represent the movement of either the steam or exhaust edges of the valve in relation to the ports.

The valve can be placed in its middle position by putting the link in mid-gear and marking on the valve-stem its extreme movement at the stuffing-box of the valve-stem. Subdivide this distance on the valve-stem, and move the subdivision to the point where the marks were made. The valve will then be in the middle of the valve-face, if the valve is set correctly.

(TO BE CONTINUED.).

* The term "boss" is used to imply an enlargement or increased thickness of any part.

Manufactures.

Marine Engineering.

SOME of the Pittsburgh coal operators are about to have built a number of iron barges to carry coal from Pittsburgh to Cincinnati and St. Louis. They will have a capacity of 30,000 bushels of coal each. Iron coal barges are, we believe, a new thing on the Ohio River.

THE Globe Iron Works in Buffalo now employ nearly 1,300 men; they have three steamships on the stocks, and are finishing two more for the Northern Line and the Lehigh Transportation Company. Four more vessels for the Northern Line are under contract.

THE yacht *Alista*, built for W. O. Wiener, of San Francisco, was launched last week at Bauner & Munn's, Wilmington, Del. It is a novel craft about 30 ft. in length only, 9 ft. beam, and 4 ft. deep, and is designed to take its owner on a solitary trip along the Atlantic Coast to Portland, Me., thence to Panama, crossing the isthmus by rail, and thence up the Pacific Coast.—*Marine Journal.*

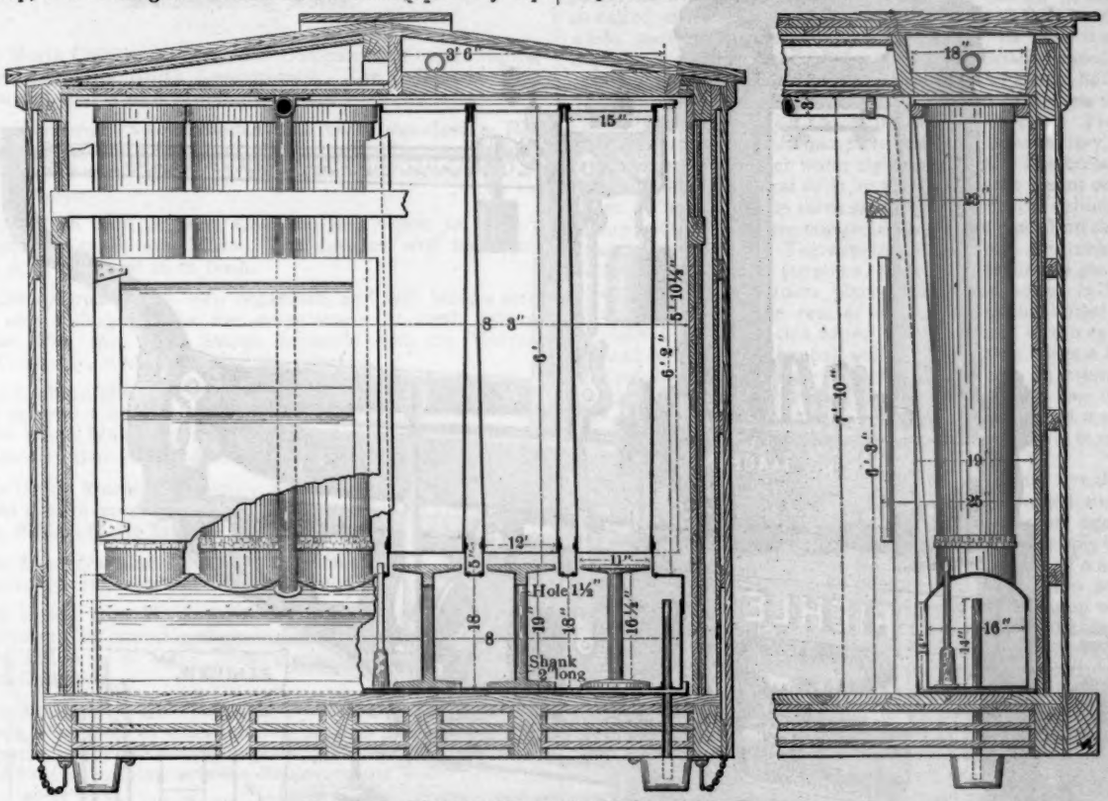
CRAMP & SONS in Philadelphia have taken a contract for a new steamship for the Southern Pacific Company, which is to be 338 ft. long, 42 ft. 8 in. beam, and 31 ft. 8 in. depth of hold, with a gross tonnage of 3,531 tons. She will have triple-expansion engines and be fitted with all improvements in ship building of the present time. Orders for materials will be given out at once, and the construction will begin as soon as the cruiser *Baltimore* is launched, as every available place is occupied by vessels in course of construction at this place.

The Bosmann Refrigerator Car.

THE accompanying illustrations (for which we are indebted to the courtesy of the *Railway Review*) are a cross section and part of a longitudinal section of the Bosmann refrigerator car, and show the leading features of the arrangement. In the end of the car are tapered ice tanks which contain the ice for cooling the car. The purpose of the tapering form is to ensure the constant contact of the ice with the tank and thus almost directly with the air. These are so constructed as to be easily removed and cleaned in a few moments. The tank at the bottom is intended to hold the water from the melting ice, and when this water reaches the top of the overflow pipe it runs off to the trap below.

There is a 3-in. pipe extending from the water tank below to the top of the car, and from thence to the center of the car along under the roof. The object of this pipe, as claimed by the inventor, is to purify the air in the car by bringing it into contact with the water where the impurities are dissolved. The constant pulsations of the water in the water tank cause the air to pulsate in and out by the air holes in the end of the pipe, and thus gradually mix the vitiated air with the air in the interior of the water tank, which has been purified by contact with the cold water. This car has all the advantages of the closed tank cars.

The ice tanks are protected from injury by the doors shown in the cut. The ice is put in at the roof as usual. The tanks made in this form furnish a maximum of cooling surface for a minimum of space occupied at the end of the car. A series of trials of this form of refrigerator car have shown it to meet the expectations of the owners.



THE BOSMANN REFRIGERATOR CAR.

It is claimed that these cars with 3,000 lbs. of ice occupying only 23 in. at each end will carry as low a temperature as some others with 4,000 lbs. of ice taking 36 in. space at each end, and that the weight is less than that of any other refrigerator car. Ten of these cars were recently ordered for the Chicago, Rock Island & Pacific Railroad, and several for the Chicago, Burlington & Quincy.

This device is now in the hands of Mr. Charles F. Pierce, whose office is in the Home Insurance Building, Chicago.

Cars.

THE Cincinnati, New Orleans & Texas Pacific has nearly completed the construction of 200 box cars at the shops at Ludlow, Ky.

THE Anniston shops of the United States Rolling Stock Company are at work on a large order for freight cars for the Anniston & Cincinnati Railroad.

IT is stated that the Canadian Pacific has contracted with the James Crossen Car Works, Coburg, Ont., for the building of 2,000 box cars, and will also build 3,000 at their own shops at Montreal.

THE Lafayette Car Works, Lafayette, Ind., have commenced the delivery of the freight cars recently ordered by the Chicago,

Burlington & Northern. They are of 50,000 lbs. capacity, 34 ft. long.

THE first lot of 300 new 60,000 lbs. ore cars, built at the Louisville & Nashville shops, Louisville, Ky., for the Birmingham Mineral road, were received at Birmingham recently.

THE Terre Haute Car Company in Terre Haute, Ind., is building a number of 60,000 lbs. coal cars for the Chicago, Milwaukee & St. Paul Railway.

THE Pullman shops at Pullman, Ill., have just turned out three very handsome dining cars for the Pennsylvania Railroad vestibule train between New York and Chicago.

THE Car Works of Osgood Bradley at Worcester, Mass., have recently completed eight passenger cars 60 ft. long for the Providence Division of the Old Colony Railroad.

ARRANGEMENTS have been completed to establish new car shops at Bristol, Tenn., and the buildings are now in progress; the shops will employ 200 men, and will begin with an order for 600 box cars.

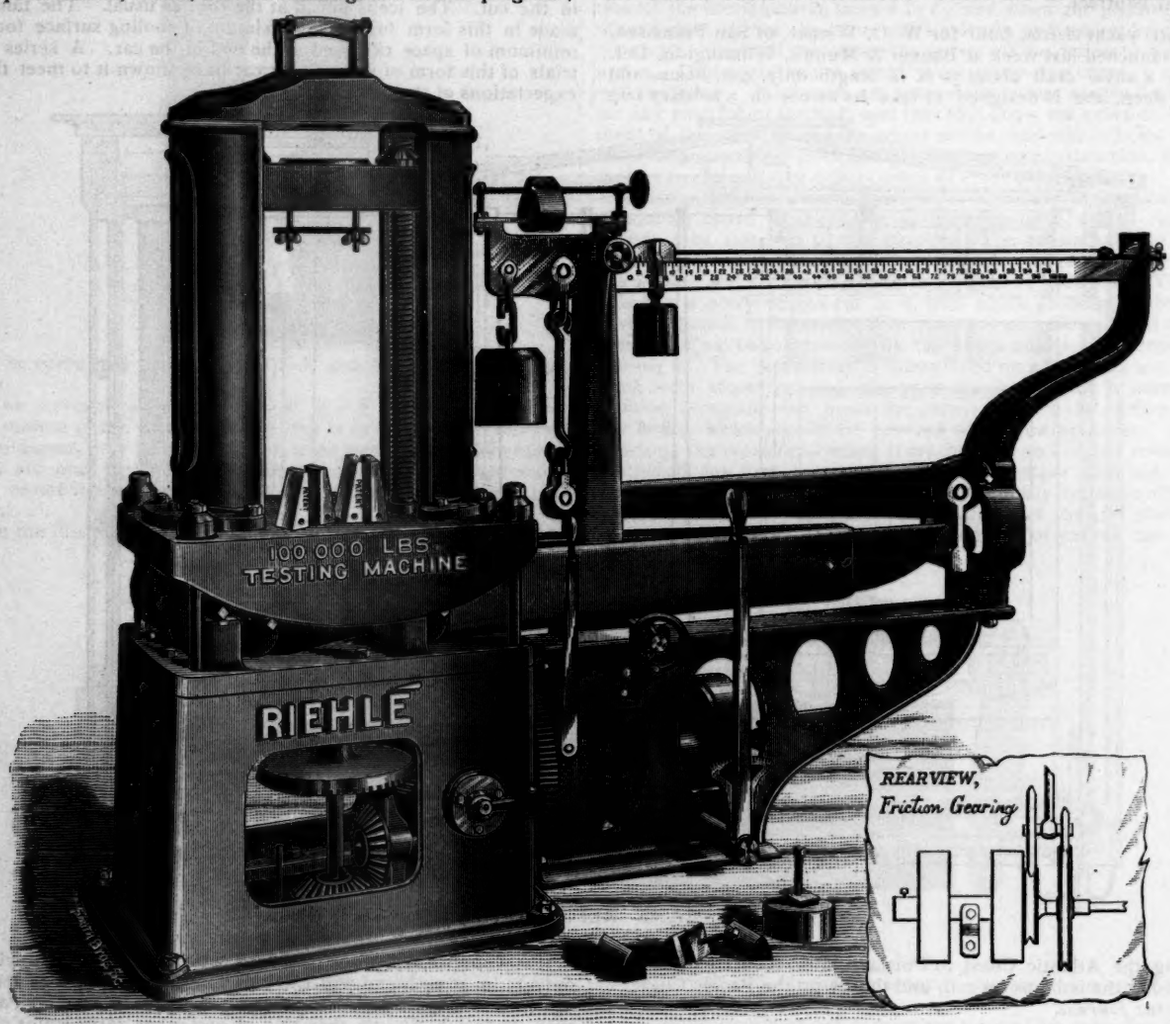
THE John Stephenson Company, Limited, is giving special attention to cable tram cars, and has perfected a system of open and close cars, removing from the car body to the car truck the mechanism of the grip, wheel brake, and track brake, thus providing open and close cars of easy motion, which are claimed to be for quiet and comfort superior to any such vehicles heretofore known.

THE Barney & Smith Manufacturing Company in Dayton, O., are building 5,000 freight cars for the Southern Pacific Company, and 100 box cars for the Mexican Central Railroad. The Company has also an order for 500 box cars of 40,000 lbs. capacity and 500 coal cars of 50,000 lbs. capacity for the Chesapeake & Ohio Railroad. The box cars are to have the Wagner car door.

THE Michigan Car Company in Detroit has recently completed a number of double-deck stock cars for the Chicago, Milwaukee & St. Paul Railway. These cars are 35 ft. long, and are carried on strong iron trucks with swing centers. All have the Westinghouse air-brake equipment, and iron break beams with a sheet-iron truss are placed on both trucks. The Safford draw bar is used. Iron troughs for watering the stock in transit are secured along the sides of all the cars.

Improved Screw-Power Testing Machine.

THE accompanying cut shows a new and improved screw-power testing machine for ascertaining the strength of metals and other materials in tension, transverse, or compression strains, combining the elements of accuracy, speed, and facility of handling. The machine is constructed entirely of iron, steel, and brass, and the levers adjusted to the standard weights of the United States Government. There are no less than six different speeds for testing a specimen, and four for driving in the opposite direction. This allows of all the possible requirements of a wide range of material. There are no loose weights, and a single traveling poise operated by a light hand-wheel registers the strain accurately by means of a vernier.



IMPROVED SCREW-POWER TESTING MACHINE.

The power is applied and reversed by means of a reversing lever, working in conjunction with a notched quadrant, and throwing a friction cone in gear with either open or cross belt as required.

In tests of compression or of material not ductile, where the pressures run up rapidly, there is an arrangement of friction V gears, similar to those of a hoisting engine, which gives an extremely slow and steady revolution of the screw, and enables the operator to weigh with ease and accuracy.

There are new anti-friction bearings of hardened steel balls, which do away with most of the friction so objectionable in the ordinary screw-power machines.

Tools are furnished with the machine for making the various

tests, and there are stops and holders for the grips, etc., as well as bolts and cushions for checking the recoil and keeping the platform in place.

The levers are arranged in tandem style, so that the machine will take up as little room as possible and allow a clear deck for transverse tests.

This style of machine is built in the following sizes: 10,000 lbs., 20,000 lbs., 30,000 lbs., 60,000 lbs., 100,000 lbs., and 200,000 lbs. capacity, and can be built of increased capacity on order.

The dimensions of the 100,000 lbs. machine are: Extreme height, 6 ft.; length, 9 ft. 3 in.; width, 2 ft. 9 in.; its weight is 4,800 lbs. For tensile specimens this machine will take test pieces up to 2 ft. long, 2 in. diameter, 2 in. square or 3 × 1 in. flat bars. Transverse specimens may be from 6 in. to 2 ft. long, and compression specimens up to 2 ft. long and 4 in. diameter. The motion of the pulling head is 2 ft. 4 in.

These machines are made by Riehle Brothers, No. 413 Market Street, Philadelphia, from whom further information can be obtained.

Manufacturing Notes.

THE North Chicago Rolling Mill Company has begun rolling steel beams at its North Chicago mill. The mill started on 6-in. beams, and is now running on 8 and 10-in.

THE Henderson Steel Company has been organized at Birmingham, Ala., and will at once begin to build a blast furnace and Bessemer steel plant. A rolling-mill and a forge will be added hereafter.

THE Duluth Iron & Steel Company has begun to build a blast furnace at Duluth, Minn. The furnace will have two stacks 75 ft. high and 16 ft. bosh.

A NEW company has been organized, and will build a steel plant and rolling-mill for the manufacture of steel tires at Latrobe, Pa. Mr. M. C. Smyth, formerly with the Midvale Steel Company, is at the head of the concern.

THE Dickson Manufacturing Company in Scranton, Pa., recently shipped a full outfit of coal-breaking machinery to a colliery in South Wales; this will be the first machinery of the kind used on that side of the Atlantic.

THE Union Machine Company, in Fitchburg, Mass., recently shipped a large quantity of machinery, including steam-engines, lathes, drills, etc., to Japan.

THE Etna Machine Company in Warren, O., is building an engine of 550 H.P. for the Hubbard Iron Company.

THE Union Iron Works in San Francisco are building two complete sets of pumping engines for the Spring Valley Water Works, and a set of large hoisting engines for a coal-mine in British Columbia.

THE Baltimore & Ohio shops at Mount Clare, Baltimore, are building a number of consolidation engines for the road; and also some heavy passenger engines, which are especially intended for fast running between Baltimore and Washington.

THE Dickson Manufacturing Company in Scranton is building 10 mogul engines with 18 by 24-in. cylinders, and six passenger engines with 17 by 24-in. cylinders and 63-in. driving wheels for the Central Railroad of Georgia.

THE King Iron Bridge & Manufacturing Company is enlarging its works in Cleveland, O., by two buildings each 70 by 600 ft., which will more than double the present capacity of the works.

THE Atlanta Bridge & Axle Company in Atlanta, Ga., is building 22 spans of iron bridge for the Central Railroad of Georgia. This work includes a new drawbridge over the Chattahoochee River.

THE plans for the new bridge over the Mississippi River at Memphis, Tenn., have been submitted to the Secretary of War, and have been referred by him to a board of engineer officers. The western approach will begin nearly three-quarters of a mile from the Arkansas bank of the river, while on the eastern side, where the bluff comes very near the river, the approach will not be more than 300 ft. long. The central span is to be 700 ft., the other span over the channel not less than 600 ft. Even this length does not satisfy the steamboat men, who, in a recent memorial to the Secretary of War, asked that the channel span should be 1,000 ft. long and at least 85 ft. above high water.

THE Safety Car Heating & Lighting Company of New York has been reorganized, with Henry R. Towne, President, and James C. Bayles, Vice-President and General Manager. In addition to the heating system which the Company has already begun to introduce—transferring the heat of steam from the engine to the water circulation in the car and retaining the water-heating stoves, to be used only in cases of emergency—it is preparing several other systems adapted to different kinds of service and not dependent upon the presence of water circulation and stoves in the car. These include direct and indirect steam heating and the circulation of hot air, the normal source of heat in each case being steam drawn from the locomotive. The Company has also acquired exclusive rights under the United States patents of the Pintsch Gas Lighting Company, and has merged that Company's business with its own. The Pintsch system is now employed on a large number of cars in this country and in Europe.

The Naphtha Launch Engines.

A NEW motive power has recently been introduced, and is finding much favor for ship's launches, small boats, and similar purposes, where a very compact engine is required. This is the so-called naphtha launch, and a number have already been built, while many more are under construction. In these boats the naphtha is carried in a tank or magazine, usually placed in the bow and separated from the rest of the boat by a tight bulkhead. This bulkhead is perforated so that the water of the sea or river circulates freely around the tank, keeping it cool. From the tank a feed and two exhaust pipes lead to the machinery, which is contained in another water-tight bulkhead. The boiler consists of a series of spiral coils under which is the steam or vapor chest. The engine has three single acting vertical cylinders the piston rods of which are connected to cranks placed on the shaft at an angle of 120°. The naphtha drawn from the tank to the boiler is used for two purposes, an injector feeding a portion of it to a burner or burners placed under the spiral coil which forms the boiler; the rest of it passes into the boiler and is vaporized, and it is this vapor which is used in the cylinders instead of steam. The coil-boiler presents so large a heating surface that the oil is very quickly vaporized. In some of the boats a pressure of 60 lbs. has been attained in two or three minutes after the burners have been lighted. The makers of this engine claim that 6 per cent. of the naphtha only is required for fuel.

After passing through the cylinders the vapor or exhaust is condensed in the exhaust pipes, which are carried under the bottom of the boat, and returns to the reservoir again as a liquid, the loss being comparatively small. The supply is regulated by valves and is kept up by an air-pump. To start the engine all that is necessary is to start this air-pump by hand, light the burners, and a very few strokes of the pump will give a sufficient supply to heat the boiler and vaporize the naphtha.

It is claimed that this power is very cheap; its economy, however, is not fully established, but the small space required for the machinery, and the ease with which the engine can be regulated, present so many points in its favor, for the purpose in which it has been used, that economy is a minor consideration. The naphtha engine can be applied to many small boats and launches where a steam-engine and boiler would take entirely too much room. A very similar device has also been introduced in England, where it is known as the "petroleum spirit engine." The arrangements in these differ somewhat from those so far adopted in this country, but the general principle is the same.

Proceedings of Societies.

American Society of Civil Engineers.

AT the regular meeting of June 6 the Secretary announced the death of William L. Baker, a member. The usual memoir was ordered to be prepared. The Secretary further announced that the circulars in relation to the Annual Meeting had been issued to members, and that most of the members from New York and vicinity would go to Milwaukee together in a special train.

A paper by Mr. James Moore was read giving his experience as engineer of the first locomotive built by Baldwin for the Philadelphia, Germantown & Norristown Railroad.

Mr. Thompson presented the Society with a photograph of the *De Witt Clinton*, the first locomotive on the Mohawk & Hudson Railroad.

The following gentlemen were elected:

Members: William Henry Baldwin, Yonkers, N. Y.; Will-

iam Murray Black, Captain of Engineers, U.S.A., St. Augustine, Fla.; Dexter Brackett, Boston, Mass.; Francis Smith Burrowes, Lancaster, Pa.; Willis Chipman, Brockville, Can.; Solomon Lefevre Deyo, Harrison, N. Y.; Henry Goldmark, Kansas City, Mo.; Lewis Muhlenberg Haupt, Philadelphia, Pa.; Joseph Warren Hoover, Kansas City, Mo.; Lewis Blake Jackson, Chicago, Ill.; Cassius William Kelly, New Haven, Conn.; Alexander Macomb Miller, St. Louis, Mo.; Richard Montfort, Louisville, Ky.; John Frank Stevens, Marquette, Mich.

Associate: Louis de Coppet Berg, New York City.

Juniors: Andre Pierre Tachard, New York City; Job Tuthill, Ionia, Mich.

THE Annual Convention was to be held in Milwaukee, beginning Thursday, June 28. Meetings for discussion and for the transaction of business were provided for on June 28, 29, 30 and July 2; the week from July 2 to July 7 will be occupied by excursions and visits to points of engineering interest in the Northwest.

Besides the papers published during the past year and open to discussion, the following new papers will be presented at the Convention:

Improvement of Rivers on the Atlantic Coast: William P. Craighill.

High Walls or Dams to resist the Pressure of Water: James B. Francis.

Maintenance of Railway Structures: Henry D. Blunden; also a general discussion on this subject.

Formulas for the Weights of Bridge Trusses: A. J. Du Bois.

An Investigation to Determine the Strains in a hollow Cast-Iron Disk, Cooled from the Interior: G. Leverich.

English Railroad Track: E. E. Russell Tratman.

An Automatic Waste Weir: A. D. Foote.

Some Facts in relation to Friction, Waste and Loss of Water from Mains: Charles B. Brush.

In addition to these papers reports were presented by a number of standing committees, including those on Uniform Time; on the Relation of Railroad Wheels and Rails; on Cements and Mortars; on Engineers on Public Works.

Boston Society of Civil Engineers.

A REGULAR meeting was held in Boston, May 16, President Fitz Gerald in the chair, 59 members and 17 visitors present.

Messrs. Edgar S. Dorr, Boston, and Edmund B. Weston, Providence, were elected members of the Society. Four names were presented for membership.

Mr. William E. McClintock, City Engineer of Chelsea, Mass., read a paper on the Construction and Ventilation of Small Pipe Sewers, giving his experience with small sewers in that city. Mr. F. P. Stearns, Engineer of the Massachusetts State Board of Health, followed with an account of the use of small sewers in other sections of the country. The subject was further discussed in written communications from Mr. F. Floyd Weld, City Engineer, Waterbury, Conn.; Mr. G. T. Nelles, City Engineer, Leavenworth, Kan.; Mr. A. R. Sweet, Engineer and Superintendent of Sewers, Pawtucket, R. I.; Mr. W. B. Pierce, Borough Engineer, Stamford, Conn.; and Mr. George A. Kimball, late City Engineer, Somerville, Mass.

Engineers' Club of Philadelphia.

AT the regular meeting in Philadelphia, May 19, Mr. William F. Sellers presented an illustrated paper on the Galloway Boiler. Mr. Henry G. Morris opened the discussion of How Should the Connections be Made between the Parts of Water-tube Boilers? which was participated in by Mr. John Overn of the Bureau of Boiler Inspectors, Philadelphia (visitor), and Messrs. M. R. Muckle, Jr., John L. Gill, Jr., J. E. Codman, Washington Jones, and others of the Club. The discussion took a wide range, covering much detail—the importance, for safety, of avoiding erroneous innovations in design and construction being specially emphasized.

Mr. Henry G. Morris exhibited, in operation, and described the Grove Electric Meter.

AT the regular meeting of June 2, Mr. A. Marichal read an elaborate paper on the Public Health of Cities and Towns, going very extensively into the subjects of water-supply, drainage, paving, street cleaning, public conveyances, and dwellings; this was discussed by Messrs. Redway, Brown, and Howard Murphy.

The Secretary presented for Mr. William S. Sheaffer notes on the Coal Deposits of Sonora, Mexico.

The Secretary presented from Mr. A. W. Sheaffer a photograph and description of the Stripping of the Mammoth Coal-bed at Shenandoah, Pa.; and also a note on Electric Haulage in Coal Mines.

The Secretary presented for Mr. G. W. Jones descriptions of a new valve motion in which the cut-off and reversing gear are worked by adjustable eccentrics.

Mr. Howard Constable presented a description of the Montague Street Electric Railroad and Terminal Station in Brooklyn, N. Y., which was discussed by members.

Professor L. M. Haupt presented an outline of a study entitled The Great Transportation Areas of the United States, in which he determined the locus of the points from which the cost of transportation to tide-water would be the same whether carried by rail entirely or partially by river and rail, or by lake, canal, and railroad. It resulted in a division of the country into five grand areas, of which the natural outlets were the Atlantic, Gulf and Pacific Coasts, the Mississippi River, and the Great Lakes. The ocean rate being but about one-sixth that by rail, it was shown how important it was to reach tide-water by the line of least resistance. The Northern and Southern or Lake and Gulf routes were briefly contrasted, and the importance of creating a deep water outlet for the grand railroad empire of the Southwest was pointed out as being one of the most important of the transportation questions of the present and the future. The extent of territory tributary to the Gulf, as the nearest point for Eastern traffic, was estimated at about 1,000,000 square miles. Attention was called to the proposed Deep Water Convention, to be held at Fort Worth, July 10, and it was stated that the present available depth is but 12½ ft., which is found on the bar at Galveston.

Professor Haupt also presented drawings showing a method of Building Tunnels under Rivers.

Engineers' Club of Cincinnati.

THE organization heretofore referred to in Cincinnati has been completed, and will be known as the Engineers' Club of Cincinnati. Civil, military, mining, mechanical, hydraulic, and electrical engineers will be eligible to full membership; scientists, managers of works, and others interested may become associate members.

The organization was completed at a meeting held May 16. The new Club starts with 40 members, and has chosen the following officers: President, Colonel William E. Merrill, U.S.A.; Vice-President, G. Bonscaven; Secretary, Russell Hinman; Directors, G. B. Nicholson, Latham Anderson, and J. Foster Crowell.

THE first regular meeting was held in Cincinnati, June 6. Professor H. T. Eddy explained and described a new formula which he had devised for reducing the labor of calculating strains in girders, where the moving load is unevenly distributed, by substituting an equivalent uniform load. He showed by diagram the polygon for the actual load and the parabola which is its nearest equivalent, and stated that his formula would generate the parabola in question with an error in the maximum stress not greater than 5 per cent., mainly on the side of safety.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, June 6. Lewis D. Jackson was elected a member. The Secretary reported that there would be a deficit on the present basis at the close of the year, and was instructed to collect the additional dues, as authorized by the by-laws. The President reported that the trustees had not yet matured any plan as to the future policy of the Society, and would report on the matter at the next meeting; he also stated that the Committee on Highway Bridges had taken action in carrying out the instructions of the last meeting. Considerable discussion occurred in regard to the functions of State engineers in the several States, and upon the general question delegated to the Committee.

Upon motion of Mr. Liljencrantz, a Committee upon Employment was ordered to consider and report at the next meeting some plan, and the necessary rules for carrying it into effect, for receiving and taking action upon applications for positions or for professional assistance from members of the

Society. After some discussion Messrs. Liljencrantz and Parkhurst were appointed as a committee.

The death of William L. Baker, a member, was announced. A committee was appointed to report suitable action on the death of Mr. Baker and Mr. Charles Lattimer.

The Secretary read a paper by Alva M. Van Auken on Classification of Material in Railroad Construction, and a supplementary paper upon the Commissary in Railroad Field Parties. The paper was discussed at length by Messrs. Weston, Gottlieb, Parkhurst, Liljencrantz, and others. It was ordered that the paper be held until next meeting for further discussion, and that the remarks be put in writing for publication.

Engineers' Club of St. Louis.

A REGULAR meeting was held in St. Louis, May 16. William T. Gould was elected a member.

Mr. Charles F. White then read a paper on the Failure of a Firmenich Boiler, which occurred by the Plant Flour Mills, in St. Louis. The construction of the boiler was described in detail, and the writer considered the failure due to faults in design and the absence of sufficient allowance for expansion. This paper was discussed. Mr. Louis Stockett then read a paper on a Well-Ventilated Mine, which was also discussed.

The Committee on National Public Works reported in favor of the general principles of the Cullom bill, with some amendments. After discussion the report was adopted.

A REGULAR meeting was held in St. Louis, May 30. The special Committee on Highway Bridges reported in favor of co-operation with other engineering clubs to secure better construction of such bridges and State inspection. The report was accepted, and Messrs. R. Moore, C. H. Sharman, and A. W. Hubbard were appointed a committee to carry out its recommendations.

Mr. R. E. McMath then read a paper on The Water-Way between Lake Michigan and the Mississippi River, by way of the Illinois River. The author having been in charge of the Government work on the Illinois River for some years, was able to treat the question in the light of experience. He referred to canals in general, and gave special attention to the various schemes connected with the Illinois River, as well as the Hennepin Canal and the complications due to the Chicago drainage. The following committees were chosen: Finance, J. B. Johnson, R. E. McMath, Robert Moore, W. B. Potter, and E. D. Meier. Correspondence, J. B. Johnson, R. E. McMath, E. D. Meier, F. E. Nipher, and C. M. Woodward. The meeting then adjourned.

Engineers' Club of Kansas City.

A REGULAR meeting was held in Kansas City, June 4. Albert N. Connett and Bolton W. De Courcy were chosen members, and Victor M. Witmer an associate member. The Secretary reported several additions to the library; also letters from a number of engineers' associations in relation to bridge reform. Most of them expressed a desire to co-operate. A committee was appointed to arrange for an excursion of the Club sometime during the summer.

Mr. Breithaupt read a paper on the crossing of the Chicago, Santa Fé & California Railroad over the Missouri Pacific and the Chicago & Alton tracks near Rock Creek. The bridge has a riveted pony truss, and is interesting on account of the necessity of keeping clear of the several tracks, the crossing being on a skew. The paper was discussed by a number of members present chiefly with reference to the number and spacing of the stringers and the effect of rigidity in bridge superstructures.

New England Water-Works Association.

THE Seventh Annual Convention met in Providence, R. I., June 13, with a large attendance, and was called to order by President Darling, who made a brief address. The Treasurer's report showed receipts of $2,585 and a balance on hand of $883.

After the opening proceedings papers were read upon Soils from which Supplies of Water may be Obtained by Driven Wells by Phineas Ball, of Worcester, Mass., and on a Water Level Indicator for Reservoirs or Tanks by W. P. Whittemore, of North Attleboro, Mass. These papers were followed by a discussion on the Best Way to Limit the Use and Weight of Special Castings.

At the afternoon session Professor J. E. Denton, of the Stevens Institute of Hoboken, presented a series of lantern views showing the Problems Involved and Methods Employed in Building the New Croton Aqueduct, New York City.

On the following day papers were read on the Aeration of Water by Natural Canals and Low Dams by S. E. Babcock and on Covered Reservoirs by Charles H. Swan, of Boston. There were discussions on both papers. A third paper on Tests by Tubular Wells was read by W. C. Boyce, of Worcester, Mass. The following officers were chosen for the ensuing year:

President, Hiram Nevons, Cambridge, Mass. Vice-Presidents, Dexter Brackett, Boston; William B. Sherman, Providence, R. I.; V. C. Hastings, Concord, N. H.; S. S. Coolidge, Bellows Falls, Vt.; George P. Westcott, Portland, Me.; Charles E. Chandler, Norwich, Conn. Secretary, R. C. P. Coggeshall, New Bedford, Mass. Treasurer, Albert S. Glover, West Newton, Mass. Senior Editor, Professor George F. Swain, Massachusetts Institute Technology, Boston. Junior Editor, Walter H. Richards, New London, Conn. Executive Committee, Frank E. Hall, Quincy, Mass.; William R. Billings, Taunton, Mass.; Edwin Darling, Pawtucket, R. I. Finance Committee. George E. Batchelder, Worcester, Mass.; James H. Hathaway, New Bedford, Mass.

The afternoon was spent in looking over the water-works of Providence.

On the third day, Thursday, a paper was read by Mr. S. E. Babcock on the Use of Relief Valves in Distribution Systems. Mr. L. F. Rice read a paper on Testing Water Meters.

Mr. W. B. Sherman, from the Committee on Blue Prints, reported that 22 members had contributed blue prints, varying from a single sheet to 100 duplicates; complete sets were given to those who had contributed, and the balance were distributed among the members.

It was resolved to hold the next meeting at Fall River, Mass. After passing the regular resolutions of thanks, etc., the Convention adjourned. On the fourth day, Friday, the members visited Valley Falls by invitation, and then took a trip down the Bay to Rocky Point, where a Rhode Island clam-bake was served.

Montana Society of Civil Engineers.

AT the regular monthly meeting in Helena, Mont., May 19, George T. Wickes was chosen a member; Mr. J. S. Keerll was appointed to represent the Society of the Board of Managers of the Association of Engineering Societies.

Mr. E. H. Beckler read a paper on Railroad Location, which was discussed by the members present; further discussion of the paper was postponed until the next meeting.

Civil Engineers' Association of Kansas.

AT the May meeting of this Association important additions to the library were made. Several communications were received requesting the Association to urge the appointment of a State Inspector for Highway Bridges.

At the June meeting the subject of Bridges was discussed. Several papers were presented by members.

American Institute of Electrical Engineers.

THE Annual Meeting was held in New York, May 15. The Secretary read his report, showing that there are now 322 members. The Institute has secured an office in the city, and has under consideration arrangements for providing permanent quarters.

Reports were also presented by the Treasurer, the Auditing Committee, and the Committee on Wire Gauge. Several papers were read by members, and the new President of the Institute made a brief address. The following officers were chosen for the ensuing year: President, Edward Weston; Vice-Presidents, E. Thomson, F. R. Upton, and T. C. Martin; Secretary, Ralph W. Pope; Treasurer, George M. Phelps, Jr.

American Association of Railroad Chemists.

A MEETING of this Association was held in Cleveland, O., May 16, with a large attendance of members and of representatives of manufacturing companies. Among the subjects discussed were; Classification of Lubricating Oils; Flashing and

Burning Tests; Thermometers; Viscosity and Specific Gravity Tests; Cold Tests, etc.

The following officers were elected: President, W. D. Gregory, New York, Lake Erie & Western; Vice-President, W. L. Brown, Chicago, Burlington & Quincy; Secretary and Treasurer, G. W. Davidson, Chicago & Northwestern

Association of Railroad Accounting Officers.

THE Committee of fifteen provided for by the convention of railroad accounting officers which met at Washington, March 28, for the purpose of considering the question of the formation of an association, met at Chicago, May 30. After mature consideration of the subject the Committee came to the unanimous conclusion that such an association was desirable. This belief appears to be shared in very generally by the railroad accounting officers of the country, so far as it is possible to judge from the great number of communications received by the Committee on the subject. The Committee have accordingly called a convention of railroad accounting officers to be held at the Hotel Brunswick, New York City, July 25, at 11 o'clock, for the purpose of adopting a constitution and by-laws and electing officers thereunder, and they invite the railroad companies to send representatives thereto. They not only invite the attendance of the representative accounting officer of each company, but they suggest to the railroad companies that they send representatives of the various departments of accounts, so that the Association may have the benefit of their advice and experience.

Master Car-Builders' Association.

THE Master Car-Builders' Association began its twenty-second annual convention at the Thousand Island House, Alexandria Bay, N. Y., on Tuesday, June 12. The convention was called to order by President McWood, who delivered a brief opening address. The reports of the Secretary and Treasurer were then presented, and the usual committees on nominations, auditing, etc., were appointed.

Messrs. D. H. Neale, C. A. Park, and F. W. Webb were elected associate members.

The report on Standard Appliances for the Safety of Trainmen was then read; it was followed by a discussion, at the close of which the recommendations made were ordered submitted to letter-ballot.

The Committee on Journal Lubrication then presented its report. This was followed by the report of the Committee on Uniformity of Interchangeable Parts of Cars. On this there was a brief discussion.

SECOND DAY.

The second day was devoted entirely to the discussion of the Rules Governing the Condition and Repairs of Freight Cars for the Interchange of Traffic. This discussion took a wide range and resulted in many amendments to the rules, with the object of making them more clear and explicit on doubtful points. The discussion on the rules was not completed until Thursday morning.

THIRD DAY.

After finishing up the revision of the rules, the Committee on Steam Heating presented its report. This was discussed at some length, and it was finally resolved that a new committee should be appointed to select two couplings for steam pipes, to be submitted to letter-ballot for adoption as standards.

The subject of a Standard Axle for 60,000 lbs. Cars was brought up and a new letter-ballot was ordered.

The Committee on Continuous Brakes for Freight Trains presented its report, as follows:

"In our report to the convention last year the main conclusion we arrived at was that the best type of brake for freight service was one operated by air, and in which the valves were actuated by electricity. Since that time your Committee has not made any further trial of brakes, but the aspect of the question has been much changed by the remarkable results achieved in non-official trials which have taken place in various parts of the country, and have been witnessed by many of the members of this Association. These trials show that there is now a brake in the market which can be relied on as efficient in any condition of freight service.

"The present position of the freight train brake is briefly as follows:

"First—Brakes can be, practically speaking, simultaneously applied without electricity throughout a train of 50 freight cars.

"Second—Other inventors are working at the problem of making an air brake which will be rapid in action and suitable for service on freight trains. We also understand that inventors are working at buffer and electric friction brakes, but we have no reason to hope that brakes on these principles can successfully compete with air brakes.

"In view of these conditions your Committee does not recommend the adoption of any particular brake, but considers that a freight train brake should fulfill the following conditions:

"First, it shall work with air of 70 lbs. pressure. A reduction of 8 lbs. shall set the brakes lightly, and a restoration of pressure shall release the brakes.

"Second, it shall work without shock on a train of 50 cars.

"Third, it shall stop a train of 50 empty freight cars when running at 20 miles per hour, within 200 ft. on a level.

"Fourth, when tried on a train of 50 cars, it shall maintain an even speed of 15 miles an hour down a grade of 53 ft. per mile without variation of more than 5 miles per hour above or below that speed at any time during the descent.

"Fifth, the brake shall be capable of being applied, released, and graduated on the whole train by the engine, or without any assistance from the brakemen or conductor.

"Sixth, the hose coupling shall couple with the present Westinghouse coupling.

"We recommend that all freight cars fitted with such a brake shall be marked 'Air brakes' on each side of the car, near the top. The Committee further recommends the use of iron or steel brake beams, and that the subject of the best form and proportion of brake gear and the selection of a standard solid brake shoe for use with metallic brake beams should be entrusted to a committee appointed for the purpose."

This report was received, and it was ordered that a Committee on Brake Gear be appointed, as recommended.

The Executive Committee presented its final report on Car Couplers. After some discussion it was ordered that the length of draw-bar, size of dead-blocks, etc., as proposed by the Committee, be submitted to letter-ballot.

Cleveland, Lake George, and Niagara Falls were named as places for holding the next convention, the Executive Committee being empowered to choose one of the three, after consultation with the Master Mechanics' Association.

The following officers were then chosen for the ensuing year: President, William McWood; Vice-Presidents, John W. Cloud, E. W. Grieves, and John S. Lentz; Treasurer, John Kirby.

Master Mechanics' Association.

THE annual convention of this Association was held, June 19, at Alexandria Bay, N. Y., where the Master Car-Builders had met the preceding week. President Setchel occupied the chair, and there was a very good attendance.

The subjects to be reported on and discussed were: Relative Proportion of Cylinders and Driving Wheels to Boilers; Guides; Extension Smoke-boxes and Brick or other Fire-box Arches; Springs and Equalizers; Tires, and the Best Thickness for them; Purification and Softening of Feed-water; Prevention of Dangerous Escape of Live Coal and Sparks from Ashpans; Tender Trucks; Traction Increasers in Connection with Over-cylindered Engines; Magnetic Influence of Iron and Steel in Locomotives on the Watches of Engine Runners.

The Committee on Amendments to the Constitution also submitted a report.

General Managers' Association of Chicago.

THE Committee (E. T. Jeffery, A. Kimball, and Henry B. Stone) to whom the question of a uniform freight car coupler was referred by this Association, have made the following report:

"The Committee appointed at the meeting of the General Managers' Association of Chicago, held November 26, 1887, beg to say that they have carefully considered the matter referred to them, and have had a personal interview with Messrs. Forney and Wall, of the Committee of Master Car-Builders' Association, on Couplers, and your Committee are much impressed with the careful manner in which they have considered the matter, and their thorough investigation and experiments.

"Your Committee therefore recommend to the Association:

"1. The adoption of what are now known as vertical hook couplers.

"2. That all such couplers be made in accordance with the Master Car-Builders' type as to size and proportions, so as to couple with each other, and be interchangeable with each other.

"Your Committee make their recommendation in this form as, after their examination, they are not yet prepared to recommend as clearly better than all others, any individual coupler, of which there are a number which are, or can be made, interchangeable with the Master Car-Builders' type,

"Your Committee find that there are conflicting claims in regard to the patents of many of these couplers, and would remind the Association of the necessity of carefully examining these before deciding on the use of any individual coupler. Those members of the Association who are also members of the Western Railroad Association can obtain full information on this point by addressing Mr. George Payson, the General Counsel of the Western Railroad Association."

OBITUARY.

HENRY C. BRUNDAGE, the architect and designer of the original Portage Bridge on the Erie Railroad, died at Dunkirk, N. Y., May 23.

LIEUTENANT-COLONEL LORENZO SITGREAVES, who died in Washington, May 14, had been on the retired list for over 20 years. From 1838, when he graduated from West Point, until his retirement he served in the Engineer Corps with credit, and was engaged in many important surveys and other works.

JOHN B. HOFF died at Elkton, Md., May 28, in his 84th year. He assisted in laying out and building the Newcastle & Frenchtown Railroad in Delaware, which was the first in the world to use steam power to convey passengers, and was all his life more or less engaged on the construction and operation of railroads.

W. R. KUTTER, author of the well-known "Kutter's formula" for the mean velocity of water flowing in open channels, and well known otherwise as an engineer and technical writer of much ability, died suddenly at his home in Berne, Switzerland, May 6. Much of his time had been devoted to theoretical investigation, and at the time of his death M. Kutter had nothing but his salary as Assistant City Engineer of Berne.

WILLIAM L. BAKER, Superintendent and Engineer of the Detroit Bridge & Iron Works, died at his residence in Detroit, May 28, aged 37 years. Mr. Baker graduated at the Rensselaer Polytechnic Institute in 1871, and very soon afterward became connected with the Detroit Bridge Works, and has remained with that Company ever since. He was known as an active man and a capable bridge engineer. His health has been failing for some time past.

DAVID BEACH GRANT, who was for a number of years the Manager of the Grant Locomotive Works in Paterson, N. J., died in Washington, June 16, aged 50 years. He was a son of the late Oliver De Forest Grant, the chief owner of the works, and had full charge of their operations for some ten years. Although not a mechanic by training, he had a remarkable aptitude for the business, and much good work was done under his charge. After leaving the Grant Works he was for a time engaged in manufacturing forgings and car-axle, but for several years past he has not been in any business.

ARTHUR A. HOBART, who died in Boston, May 23, aged 56 years, had seen much and varied service on railroads. Beginning as a conductor on the Chicago & Northwestern Railroad, he was in 1870 appointed Superintendent of the Milwaukee and Wisconsin divisions of that road. From 1876 to 1879 he was Assistant General Superintendent of the Chicago, Burlington & Quincy, resigning in the latter year to accept the position of Superintendent of the Troy & Boston road. He was afterward for a short time Superintendent of the Boston & Lowell, and in 1882 he returned to the West and accepted the superintendency of the Chicago Division of the Wabash, St. Louis & Pacific. His last position was Superintendent of the Eastern Division of the Chicago, St. Paul, Minneapolis & Omaha, which he resigned some two years ago on account of ill health and removed to Boston. In the West Mr. Hobart had a high reputation for his ability in handling train service on a crowded road.

PROFESSOR ROLAND DUER IRVING died at Madison, Wis., May 30, aged 41 years. He was born in New York City, and was a graduate of the Columbia College School of Mines in the class of 1869. The degree of Ph.D. was conferred on him by that institution in 1879. After serving as assistant in the Ohio Geological Survey, he was elected in 1870 Professor of Geology, Mining, and Metallurgy in the University of Wisconsin, and he has since retained that position. From 1873 till 1879 he was Assistant State Geologist of Wisconsin. In 1880–82 Professor Irving was one of the United State census experts, and in 1882 he was placed in charge of the Lake Superior Division of the United States Geological Survey. He was a member of various scientific societies, and contributed important papers to their transactions, besides publishing valuable official reports on geological subjects. Professor Irving was recently asked by Mr. Powell of the United States Survey to attend a scientific conference to be held in Europe this summer, and was considering the matter when taken down by his last illness.

ALFRED DURAND-CLAYE, who died in Paris, April 27, aged 42 years, was a graduate of the Ecole Polytechnique and the Ecole des Ponts et Chaussées.

In 1866 he was attached to the city service of Paris as Engineer of the third rank, and became a colaborer with M. Alphaud and a colleague of Couche, Bartet, and André. He was always an earnest advocate of the method of sewerage known as "Tout à l'égout," so long opposed in Paris. With M. Mille he established the sewage irrigation system at Gennevilliers and made it successful. He believed it would disprove all the agricultural, hygienic, and practical objections that were made to it. He had planned to take another portion of the Paris sewage to Achères, and though he did not live to see the realization of this project, his associates zealously continue the work.

The name of M. Durand-Claye has been connected with all the great subterranean highways of Paris that have been executed within a score of years. He had opponents in the special field of sanitary improvement to which he was devoted, but no enemies, and the numerous publications in which he has grouped the field experiments at Gennevilliers and his studies on the sewers of Paris and of other great European cities are equally consulted by his allies and antagonists.

M. Durand-Claye was Chief Engineer of the Drainage System of Paris, Ingenieur en Chef des Ponts et Chaussées, Professor in l'Ecole Nationale des Ponts et Chaussées and in l'Ecole des Beaux-Arts, and a member of many leading technical societies, and an officer of the Legion of Honor.

PERSONALS.

H. G. TAYLOR has been appointed Superintendent of the Calumet & Chicago Canal & Dock Company's works.

WILLIAM M. GREENE has been appointed General Manager of the Cincinnati, Indianapolis, St. Louis & Chicago Railroad.

COLONEL W. H. PRYOR, of Lynchburg, Va., is now Chief Engineer of the Atlantic, Atlanta & Great Western Railroad.

JAMES OWEN has been appointed Engineer and Superintendent of the Montclair Water Company's works at Montclair, N. J.

J. R. RENIFFE has been appointed Master Car-Builder of the Flint & Pere Marquette Railroad, with office at East Saginaw, Mich.

J. J. CASEY has been appointed Superintendent of Motive Power of the Louisville, New Orleans & Texas Railroad, with office at Memphis, Tenn.

A. E. SWAIN, of Kansas City, Mo., has been appointed Assistant Chief Engineer of the Mexico Pacific Railroad, a projected line from Hermosillo to Mazatlan.

WILLIAM GORSTANG has been appointed Superintendent of Motive Power of the Chesapeake & Ohio Railroad. He was recently on the Cleveland, Columbus, Cincinnati & Indianapolis road.

COMMANDER R. D. EVANS, U.S.N., has been relieved from duty as Secretary of the Lighthouse Board, and has been ordered to the New York Navy Yard to take charge of the construction of the armored cruiser *Maine*.

H. N. BURFORD has been appointed Superintendent of Motive Power and Rolling Stock of the Texas & Pacific Railroad, with headquarters at Marshall, Tex., to fill the vacancy occasioned by the resignation of Jacob Johann.

HENRY TREGELLES has been appointed Master Mechanic of the Susquehanna Division of the New York, Lake Erie & Western Railroad. He has for some time had special charge of the air brakes and brake service on the road.

GEORGE W. CUSHING has resigned his position as Superintendent of Motive Power of the Philadelphia & Reading Railroad. He has been on the road but a short time, having gone there from the Northern Pacific less than a year ago.

HERMAN WINTER has resigned his position as Consulting Engineer of the Southern Pacific Company (Morgan Steamship Line) on account of ill health. Mr. Winter has had charge of the design and construction of a number of large steamers for the company.

ASSISTANT ENGINEER WILLIAM J. BAXTER, ENSIGN CHARLES H. HEWES, and ENSIGN WASHINGTON T. CAPPS have been appointed Assistant Naval Constructors by the Secretary of the Navy. The three officers have been for some time studying shipbuilding in Scotland.

GEORGE RICHARDS has been retired from the position of Master Mechanic of the Boston & Providence Railroad, owing to the lease of that road by the Old Colony Company. He has held the office since 1870, and had been 39 years on the road, beginning as a machinist in the shops in 1849.

CAPTAIN EDWARD BURGESS, of Boston, has been appointed Chairman of the Board to consider and report on life-saving appliances by the Secretary of the Treasury. He is very well qualified for the position by his experience in that direction. Captain Burgess is also well known as the designer of the famous yachts *Puritan* and *Mayflower*.

J. A. L. WADDELL and W. D. JENKINS have formed a partnership and will hereafter conduct business together as consulting and civil engineers, having their offices at No. 118 West Sixth Street, Kansas City, Mo. Both gentlemen have had wide experience in designing and constructing bridges and similar structures. Mr. Waddell will attend specially to superstructure, and Mr. Jenkins to substructure and foundation work.

GENERAL W. B. FRANKLIN has been appointed by the President Commissioner-General of the United States to the Paris Exposition of 1889, and has accepted the position. General Franklin graduated from West Point in 1843, and served in the Army from that time until 1866, reaching the rank of Colonel of the 12th Regular Infantry and Major-General of Volunteers. Since 1866 he has been head of the Colt Fire-Arms Manufacturing Company, at Hartford, Conn. Mr. Somerville P. Tuck, of New York, will be the Assistant Commissioner-General under General Franklin.

GEORGE B. MALLORY, the well-known marine engineer, has been appointed Consulting and Chief Engineer of the Southern Pacific Company's steamship line (the Morgan Line) from New York to New Orleans and Gulf ports. Mr. Mallory will have charge of the design and construction of all new steamers for the line.

Mr. Mallory has also been appointed Consulting Engineer of the Keystone Bridge Company of Pittsburgh.

THE following changes in the Engineer Department of the United States Navy are announced: CHIEF ENGINEER J. W. MOORE is ordered from New York to the Mare Island (Cal.) Navy Yard, replacing CHIEF ENGINEER GEORGE F. KUTZ, who is ordered to duty as Inspector of Machinery at the shipyard of William Cramp & Sons, Philadelphia. He relieves there CHIEF ENGINEER H. W. FITCH, who is ordered to duty at the Naval Academy at Annapolis, where he replaces CHIEF ENGINEER EDWARD FARMER, who is ordered on sea service. CHIEF ENGINEER JOSEPH TRILLEY is ordered from the receiving ship *Wabash* to the Portsmouth Navy Yard, relieving CHIEF ENGINEER W. B. BROOKS, who is placed on waiting orders.

NOTES AND NEWS.

The Typewriter.—In 1829 drawings and specifications covering the invention of a typewriter, which closely resembles the construction of the modern typewriter, were deposited at the United States Patent Office, the certificate of registration being signed by Andrew Jackson. The earliest patent of all appears to be one filed in the British Office in 1714, No. 395.

The Stampede Tunnel.—The headings in the Stampede Pass Tunnel on the Cascade Division of the Northern Pacific Railroad met on May 3, and trains ran through it early in June. This tunnel was begun two years ago, and is among the longest in the world. It is 9,850 ft. long in all and is 16 ft. wide by 20½ ft. high in section. The rock throughout was a gray conglomerate basalt, of medium hardness, but slacking and scaling on exposure to air, rendering timbering necessary. The contractor was Wilson Bennett. The we t end approach consisted of open cut through trap rock, while the east end enters the tunnel by crossing a creek immediately under a cataract, which has a fall of 160 ft. Before crossing this creek the track is made by cutting a heavy ridge or slide of earth and loose rock. These two approaches contained in the aggregate upward of 30,000 cubic yards of material, most of which was solid rock, which had to be blasted.

The St. Clair River Tunnel.—After a long period of waiting, work on the proposed tunnel under the St. Clair at Port Huron is again actively under way. The developments so far are most satisfactory, the measurement showing more than the required thickness of clay everywhere, with no fault or break discoverable. The shoe on the American side was successfully put in place recently, and the shaft is now being excavated.

On the Canadian side good progress is being made, and the brick lining has been lowered by successive drops of from 4 to 8 ft. each, until it is now half way or so to bed-rock. A blower for forcing air down the shaft and the electric light plant of the machinery will soon be in place.

The tunnel is to be built by a separate company, but will be used by the Grank Trunk Railway trains.

Snow on the Gothard Railway.—On February 15, after a prolonged fall of snow, an avalanche fell blocking up the Gothard Railway and causing the death of five workmen. About 3 o'clock in the day an avalanche had fallen directly in front of the southern entrance to the covered way near Wasen. Workmen were sent to clear the line, but they had not been thus employed for more than one-half hour before a fresh avalanche rushed down, this time blocking up the northern entrance and covering the unfortunate workmen to a depth of several feet. The snow was forced up the gallery for a distance of 50 ft., while the débris from the avalanche extended nearly 350 ft. further, and was so compact that it was necessary to use pick-axes in removing it. The rescuing party succeeded in finding one of the workmen alive, though the other five were all dead. It is stated that the severity of the avalanches in this district is due to the gradual deforesting of the hill slopes.

Locomotives on the Canal.—About two weeks since the London & Northwestern Railway officials made an experiment as to drawing canal boats with a locomotive. A track of 18-in. gauge and about a mile in length had been laid along the canal bank. On it was placed a small locomotive. When steam was up two boats were attached by ropes to the locomotive, which drew them along easily at the rate of seven miles an hour. Four boats were then attached, and the same speed was attained, the engine working very smoothly. The experiment was deemed successful, and if it was in fact successful, it is difficult to see why the thing could not be done on a much larger scale on the Erie Canal.

Orders have been given for the construction of several engines of a small pattern to run on sets of rails to be laid alongside this canal, the rails being laid 18 in. apart. The engine drew eight laden boats at the rate of four miles an hour.—*Engineering News.*

The Longest Tangent in the World.—The new Argentine-Pacific Railroad from Buenos Ayres to the foot of the Andes has on it what is probably the longest tangent in the world. This is 340 kilometers (211 miles) without a curve. It is also a remarkable fact that in this distance there is not a single bridge and no opening larger than an ordinary culvert. The level nature of the country will be appreciated from the statement of the further fact that on the 340 kilometers there is no cut greater than one meter in depth and no fill of a height exceeding one meter. The country, in fact, seems to be almost an ideal one for railroad construction.

There are some drawbacks, however, one being that there is almost an entire absence of wood on the plain across which the western end of the road is located. This has led to the extensive use of metallic ties, which will be used on nearly the entire road. Work has already been begun on the mountain section of the road, which is to cross the Andes and unite with the Chilian line.

New System of Sewerage at Frankfort-on-the-Main.—In spite of the strong current and the great dilution, the previous system of disposing of the sewage at Frankfort-on-the-Main in the river Main has proved unsatisfactory, causing a great many complaints, and the corporation was therefore obliged to find some remedy. The course adopted by them was to cleanse the sewage before giving it access to the river, by purifying it. Experiments with this end in view have led to satisfactory results, gypsum being adopted as the chemical

cleaner. The sewage is first mechanically cleaned, as far as it is possible, and is then led into the clearing reservoir, which is about 300 ft. long and 100 ft. broad, with a depth of 18 ft. below high-water mark. The water passes through the reservoir at the extremely moderate rate of 5 millimeters in the second, which leaves ample time for the solid particles to settle. When the reservoir has to be cleaned, the water is first pumped out and the sediment removed by another special pump. The pumps and the machinery are so placed that the suction pipes need only be short ones.

The Redwood Forests of California.—In the redwood forests adjacent to San Francisco Bay and lying in the counties of San Mateo, Santa Cruz, Marin, Sonoma, Napa, and Alameda, most of the merchantable timber on the original growth has been removed, as the drain on these forests has been enormous. In the greater portion of these worked-over forests, where the stumps have not been removed to make way for fruit trees or vines, the great vitality of the redwood has asserted itself, and a dense growth of saplings has sprung from the mutilated butts, and is rapidly approaching a merchantable condition. The redwood forests on the range east of St. Helena, in Napa County, supplied all the ties used in the construction of the Napa Valley Railway, and the growth has been drawn upon for years past for posts and stakes for the vineyards and orchards that are taking the place of the forests. Railroads have not yet penetrated these forests, but when they do, as they are likely to do within a few years at least, they will acquire a great commercial value. As the redwood is the best and, indeed, the only timber available on a large scale, it is a great pity that the forests are being destroyed.

The Perekop Canal.—The Russian Government has begun the work of cutting the Perekop Canal, the original survey for which was made many years ago. This canal is to extend across the Isthmus of Perekop, connecting the Sea of Azoff with the Black Sea. It will be 111 versts (74 miles) long, and the present expectation is that it will be completed in 1891. As with most Russian works, the main object is military, to enable war steamers to pass from the Sea of Azoff to the dock yards and forts of Odessa without circumnavigating the Crimea or passing through the dangerous straits of Kertch; but the canal also has commercial importance. The bulk of the trade from the Don River and a great deal of that from the upper Volga goes to Odessa, and the new canal will very much shorten the voyage for all the vessels engaged in this business, besides securing the further advantage that the grain barges employed on the Don will be enabled to carry their loads directly to Odessa without transshipment, the frequent storms on the Black Sea now making it necessary to transfer the loads of these barges to sea-going vessels at present. The canal presents no special engineering difficulties.

Railroads in Corsica.—Until February 1, 1888, the island of Corsica has been entirely destitute of railroads, but during nearly the whole of the present century the postal service, by diligence, has been as good in Corsica as in almost any part of the Continent, owing to the superb system of graded and macadamized roads.

But railroads are an essential adjunct of modern commerce; without them the mines of iron, lead, copper, antimony, and zinc in the interior could not be profitably worked, and the export trade of the island could not compete with that of Italy and France.

Soon after the organization of the present French Republic, the Corsican deputies began to demand for their picturesque island a railroad system, but the high range of mountains which traverse the island, the spurs of which, in many places, run down to the coast and terminate in abrupt headlands, would necessarily make the work expensive, while the high cost of operating lines involving heavy gradients rendered the profit of the undertaking more than doubtful.

The National Government came to the rescue and surveyed the main line from Ajaccio to Bastia. Work was begun at Bastia seven years ago, and on the first of last month the road was opened for traffic as far as Corte—a distance of 45 miles. By reason of the high grades, numerous rock cuttings to be overcome, its cost has been $33,250 per mile. The tunnel, 10 miles south of Corte, is a difficult and costly task which cannot be finished in less than a year. The main line, from Bastia to Ajaccio, is a national work built by Government engineers at the expense of the State.

At present Corsica exports to the United States little except candied citron, and receives in return petroleum and leaf tobacco. If Corsican wines were as well known in our country as they deserve to be a large American trade in them might be developed. There are almost no manufacturers on the island, and it offers a promising market.

Egyptian Petroleum Fields.—Colonel Stewart has recently completed and submitted to the Egyptian Government a preliminary report on the result of his researches in the petroleum district, from which it would appear that he recommends experimental borings to the north of Jebel Tor, on the opposite side of the Gulf of Suez, where he claims to have discovered many indications that justify the conclusion that good results will eventually be obtained.

His proposals, it is understood, will be given due consideration as soon as a supplementary report, with details as to cost, etc., can be prepared and examined.

It would seem from this that, notwithstanding the many disappointments that threatened to end with failure to which the Egyptian Government has been subjected in its experiments at Jebel Zeyt and Gimsah, it is nevertheless disposed to venture additional sums in prosecuting the search for petroleum in the hope of finding it in sufficient quantities to compensate it for the enormous expenditures already incurred.

It was confidently hoped and maintained that oil in remunerative quantities was more than likely to be encountered at a depth of about 1,000 ft.; but the limit has long since been reached, and passed by many hundred feet, and the long and much-wished-for expectations are yet to be realized. It seems clear that the Government, having lavishly expended—not to say wasted—extravagant sums in the development of what promised to prove a source of great revenue to its greatly depleted and needy exchequer, does not appear to be willing or feel justified in relinquishing its exertions and labors until all hope of success must be finally abandoned.

Of the presence of petroleum over a vast area there exists no longer any doubt, but whether its extraction will ever yield a proper remuneration or return is yet problematical. It is not improbable that the present generation will have to follow the example of those that preceded them thousands of years ago, who, from indelible traces left to posterity, were fully aware of the existence of petroleum, but appear to have abandoned its exploitation as an unprofitable task.—*Report of Consul Bissinger, at Beirut, to State Department.*

Baltimore & Ohio Employes' Relief Association.—The report of this Association for the year ending September 30, 1887, shows total receipts for the year of $367,350, and a balance of $205,907 on hand at its close. Payments of benefits during the year were:

	No.	Amount.
Deaths from accident	73	$80 000
Deaths from other causes	130	57,496
Disablements from injuries	3,974	53,521
Disablements from sickness	6,517	97,590
Surgical bills	2,259	13,835
Total	12,953	$302,442

The business of the Association has largely increased during the past year, as shown by the fact that the present active membership is 22,155, an increase over last year of 1,858. Since the inauguration of the Association (May 1, 1880) 70,029 persons have been admitted to membership, of which number 10,922 made application during the past fiscal year.

The examination to determine the physical condition of persons applying for membership has resulted in the rejection of 1,460 out of a total of 18,353, and of 149 of those who were examined for sight, hearing, and color sense.

The Savings Fund and Building Feature shows total deposits of $441,804. During the year 381 new deposit accounts were opened. The total amount received from depositors during the year was $221,893, an increase over the previous year of $12,103, making the aggregate of deposits since August 1, 1882, when the Savings Fund was inaugurated, $730,560; of which $288,756 have been withdrawn, and the sum of $453,787 has been loaned, at the rate of 6 per cent. interest, to those employés desirous of obtaining homes upon the lines of the Railroad Company, of which $122,109 have been repaid.

This amount was expended in building 259 new houses, buying 257 houses, improving 69 houses already owned, and releasing liens in 153 cases. The loan feature has become exceedingly popular, the applications to utilize this feature largely exceeding, during almost the entire year, the funds available for this purpose.

Railroads in Colombia.—A consular report submitted to the Department of State says that the railroad system of the interior of Colombia is as yet in its embryonic stage and slow in growth. The only road in actual service is the Bolivar, between Barranquilla and Salger. The railroads to be considered are the Bolivar, Cauca, Jirardot, the Antioquia, and the Dorado, the Bolivar being the first in importance and in its service and aid to foreign commerce as well as in its perfect management.

The mouth or delta of the Magdalena River is obstructed more or less at all seasons by a shifting bar formed by the sedi-

ments of the Magdalena and its tributaries. Vessels enter the river with from 18 to 20 ft. of water on the bar, but a few days later, when cleared for departure, there may be but 9 or 10 ft., and vessels have been lost on the bar when in tow of a powerful tugboat and piloted by one of the best experts on the coast. It was to obviate this peril to life and property that the Bolivar Railroad was constructed.

When the branch to Puerto Colombia is completed, steamships can lie alongside a pier in smooth water to discharge and receive freight.

The Bolivar is under American management; it is owned by private parties. The rolling stock now in service, of English manufacture, will be replaced as the necessity arises with American. The extension of the branch road to Puerto Colombia, on the northwest side of Salger Bay, makes the distance from the Barranquilla terminus to the pier 18 miles. The Salger terminus will probably be abandoned in the immediate future.

The Cauca Railroad, the construction of which was commenced in 1878 and which was to connect with Cali and the west bank of the Cauca River, has its present terminus at Cordova, 12 miles from Buenaventura. It is now Government property; has been surveyed to Cali, but the work has been suspended.

The Jirardot Railroad has been completed to Portillo, 12 miles. The line has been surveyed to Bogota, a distance of about 80 miles. It is a Government enterprise, and presents engineering difficulties of no ordinary character. The work is progressing slowly, but owing to the topographical features of the route 6 per cent. gradients will be necessary at several points on the line of survey; and it is considered doubtful whether the road when completed will ever pay its running expenses.

The Dorado Railroad is a portage road between the navigable waters of the lower and the upper Magdalena around a series of rapids and falls at Hondo, which forms a barrier impassable by steamboats.

The bridge across the river at Hondo will probably be built in the future, but as yet nothing has been done toward its construction. Some five years ago a Colombian railroad enterprise was inaugurated to construct a railroad from Puerto Wilches, on the eastern bank of the Magdalena River, to follow the valley of the Sogomosa River and reach Bueurmauga. The line was surveyed and a short section of track, less than a mile, was laid.

The Antioquia Railroad from Puerto Berrio to Medellin, 125 miles, has been completed to Pavis, 30 miles from Puerto Berrio. The first contract for this road was signed in February, 1874, modified May following, and in July, 1876, a new contract was made for the termination of the line at Barbosa, a distance of 100 miles from Puerto Berrio. This also is a road of heavy gradients.

Petroleum and Natural Gas in Japan.—From an article prepared for the *American Manufacturer*, by Jinzoo Adachi, we learn that petroleum and natural gas are found in Japan. They were known there at least ten centuries ago, but have never been used until recently. This has been partly from the abundance of vegetable oil and wood fuel which cover the whole of Japan, but more from the peculiar policy of a long reign of feudalism.

The oil-bearing rocks in Echigo consist of soft, greenish-gray shales and gray fine-grained sand rocks, sometimes with small quartz pebbles. In Echigo fibrous lignite is sometimes closely associated with black shining coal. The oil-bearing rocks appear generally to be in folds that have axes running nearly northeast and southwest, sometimes so sharply waving as to form perfectly closed folds with the dip reversed on one side.

The present mode of oil-well digging is very simple, and not many more men are needed than for boring with steam. The digging is all done by two men, one of whom digs in the morning from 9 o'clock until noon, and the other from noon until 3 o'clock. The one who is not digging works the large blowing machine or bellows that continually sends fresh air to the bottom of the well.

The oil is never pumped, but is hoisted out of the well by buckets. These buckets are attached to a rope, which runs over a wheel at the surface, and while one bucket is coming up the other is going down, the weight of the empty bucket thus helping the one man who does the hoisting. The average bucket contains five gallons.

The American method of well drilling has been tried twice, but has failed. The Japanese plan is to dig a well 3½ ft. square, resembling the vertical shafts of the mines of Pennsylvania.

A well 300 ft. deep would cost $300, and would be completed in three months.

In Echigo there are several yielding oil wells of small product, but the most interesting feature is a couple of gas wells some 10 ft. in diameter, near together, where the gas bubbles up in great quantity with violent commotion in water nearly level with the ground, and burns with dancing, flickering flames when lighted. At another spot within half a league some gas is utilized in a house for cooking, lighting, and even as a spectacle when burned in jets of various size and position; but all the flames are flickering ones. At the same place the gas is used to heat a small rude still for refining the oil of the neighboring regions.

In 1874 the total production of petroleum was 123,156 kwan, and in 1884, 1,139,624 kwan.

The number of productive wells in 1879 were 874; average daily yield, 4 gallons; average depth, 177 ft.; greatest depth, 780 ft.

The results of practical refining from the crude oil at Echigo show an average of about 60 per cent. of refined oil.

The International Exhibition at Berlin for the Prevention of Accidents.—The Prussian Government has permitted the gratuitous use of a large exhibition place in Berlin near the Thiergarten and the Lehrte railroad station, for the purpose of showing practically how accidents may be prevented. The exhibition is to take place from April to June, 1889. The invitation to participate in the exhibition is extended to all nations.

The articles to be exhibited are to consist of machinery, apparatus of all kinds now in use to guard against accidents, in tools, working pieces and working materials, in models; in plans, drawings, photographs and specifications; in copies of regulations, rules for factories, statutes and printed matter relating to accidents and to their prevention. All articles that relate generally to the protection of laborers will be admitted.

The exhibition will have, to some extent, the character of an industrial exhibition, with the difference only that objects which are solely for technical purposes are excluded.

Groups 1 to 12 contain detailed suggestions to enable manufacturers and masters to answer for themselves the question, how far their participation in the Exhibition may be conducive to valuable results.

The division into groups is as follows:

DEPARTMENT A.

Groups 1 *and* 2: Prevention of accidents near movable machine parts, generally; productive devices in transmission shafts, toothed wheels, beltings; disengaging gear, lubricating appliances, etc.

Group 3: Protective measures in the working of elevators, lifters, cranes, derricks and other raising apparatus and machines.

Group 4: Protective measures on motors.

Group 5: Protective measures in the operation of steam boilers and other apparatus under pressure.

Group 6: Preventive devices against, and safety devices in case of, fire in insured works and workshops.

Group 7: Providing for good illumination and prevention of accidents by means of lighting arrangements.

Group 8: Prevention of accidents caused by poisonous (caustic or corrosive substances) obnoxious gases, etc.

Group 9: Personal equipment of laborers.

Group 10: Provision for injured persons.

DEPARTMENT B.

Group 11: Steps for the protection and well-being of working people in the metal industry.

Group 12: Steps for the protection and well-being of working people in the wood industry.

Group 13: Steps for the protection and well-being of working people in the textile industry.

Group 14: Steps for protection in the paper, leather, and polygraphic industries.

Group 15: Protection in the industry of articles of food and consumption.

Group 16: Protection in the chemical-glass industries.

Group 17: Protection in the mining and quarry industries.

Group 18: Protection in building trades.

Groups 19 *and* 20: Protection in the trades of intercommunication.

Group 21: Protection in the farming and forestry industries.

DEPARTMENT C.

Group 22: Literature (Library of the Exhibition).

Special attention has been bestowed upon protective measures for movable machine parts, as official statistics compiled for the year 1886, at the Imperial Insurance Office, show that, irrespective of the prevalence of various occasions for accidents in the several trades, in the entire sphere in "insurance in case of accidents," such accidents as were caused by movable machine parts occupy, among the more severe cases, the first place in number. Not less than 100,000 cases of accidents were reported in the year 1886; 10 per cent. of the laborers injured under the insurance laws being entitled to an indemnification.